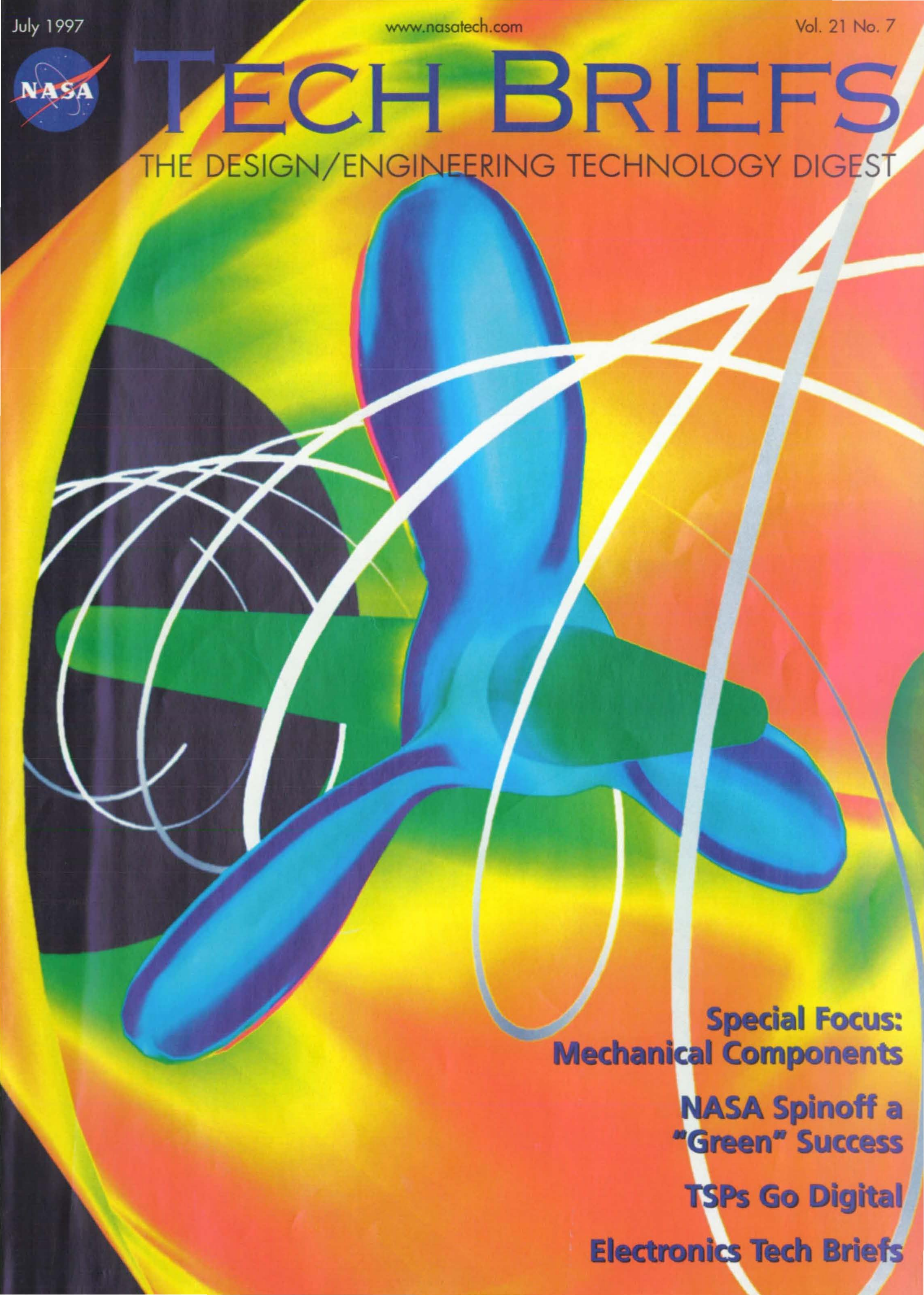
July 1997
www.nasatech.com
Vol. 21 No. 7

TECH BRIEFS

THE DESIGN/ENGINEERING TECHNOLOGY DIGEST



Special Focus: Mechanical Components

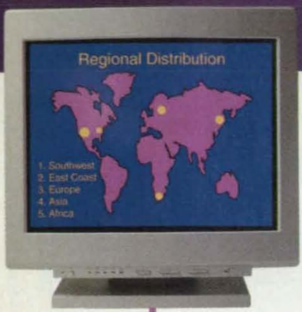
NASA Spinoff a "Green" Success

TSPs Go Digital

Electronics Tech Briefs

omega.com™
OMEGA®
One Omega Drive, P.O. Box 4047
Stamford, CT 06907-0047
http://www.omega.com
e-mail: info@omega.com
Collection Series #2-117005
To Request Your DILBERT™ Deck Card Pack, Dial: 1-(203)-329-1266
DILBERT® by Scott Adams
I WANT YOU TO HELP ME UPGRADE THE COMPUTER IN MY OFFICE.
THE COMPUTER IN YOUR OFFICE IS A CARDBOARD PROP THAT CAME WITH YOUR DESK.
SO, I NEED A NEW MOTHER-BOARD, RIGHT?
NO, YOU NEED A NEW DESK.
E-Mail: SCOTTADAMS@AOL.COM
© 1994 United Feature Syndicate, Inc.
4/27/94
DILBERT © United Feature Syndicate, Inc.
Get Your Dilbert® Card Deck Circle No. 540
Laugh When You Receive Dilbert® Card Deck #2 !
Where Do I Find Data Acquisition Systems for Temperature Measurement?
OMEGA...Of Course!
High Speed and Process Measurement System
Document #6255 OMEGAfax
Model OMB-TEMPSCAN-1100
$2190
Isolated Temperature and Voltage Measurement System
Model OMB-Multiscan-1200
$2490
Document #6321 OMEGAfax
Portable Data Acquisition System
KMTSS-125G-6 thermocouple sold separately.
Model OMB TEMPBOOK-66
$1095
Document #6354 OMEGAfax
Digital Conditioners
DRX SERIES
$250
Document #6409 OMEGAfax
omega.com™
OMEGA®
As Seen In...
© COPYRIGHT 1997 OMEGA ENGINEERING, INC. ALL RIGHTS RESERVED
Patent Applied For
For more information, call OMEGAfax℠ on-line publishing service at 1-800-848-4271 and request desired document numbers.
For Sales and Service, Call:
1-800-82-66342℠
1-800-TC-OMEGA
e-mail: info@omega.com
See Dilbert® On The Reverse Side Of This Card!
Where Do I Find Dataloggers?
OMEGA...Of Course!
Low Cost Temp and Humidity Datalogger
Document #6358 OMEGAfax
NOMAD™ DATA LOGGER OMEGA
Model OM-NOMAD
$135
Basic Unit
omega.com™
OMEGA®
Low Cost Handheld Datalogger
Model AD128
$799
Document #6365 OMEGAfax
Expandable Datalogging System
Model OM-320
$3000
Basic Unit
Document #6395 OMEGAfax
http://www.omega.com
Low Cost Versatile Datalogger
Document #6404 OMEGAfax
Model OM-180 Series
$640 Basic Unit
For Sales and Service, Call:
1-800-82-66342℠
1-800-TC-OMEGA
© COPYRIGHT 1997 OMEGA ENGINEERING, INC. ALL RIGHTS RESERVED
Patent Applied For
For more information, call OMEGAfax℠ on-line publishing service at 1-800-848-4271 and request desired document numbers.
NEW! FREE!
Vol. MM™
21st Century™ Preview Edition
YOUR SOURCE FOR
Temperature
Flow & Level
Pressure, Strain & Force
Data Acquisition
pH & Conductivity
Electric Heaters
Environmental
Request The Vol. MM™ 21st Century™ Preview Edition Circle No. 541 or Request Document #9989, OMEGAfax℠ Service, or Dial 1-800-848-4271
http://www.omega.com
e-mail: info@omega.com
21st Century™ Preview Edition
NEW FREE!
OMEGAfax℠
OMEGA's 24-Hour-a-Day, On-Demand Publishing Service
DIAL 1-800-848-4271
For Sales and Service Call:
1-800-82-66342℠
1-800-TC-OMEGA
ISO 9001 CERTIFIED CORPORATE QUALITY
omega.com™
OMEGA®
OMEGA ENGINEERING, INC., ONE OMEGA DRIVE, P.O. BOX 4047, STAMFORD, CT. 06907-0047
©COPYRIGHT 1997 OMEGA ENGINEERING ALL RIGHTS RESERVED.

TO CONVERT REAL-TIME COMPUTER GRAPHICS TO VIDEO...



...and get the best possible image, you will need the Model 9400JR or Model 9700XL from Folsom Research.

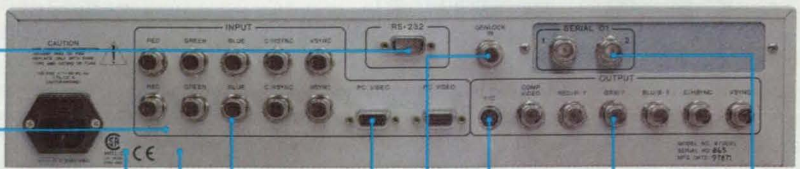
1280x1024 Computer Display

NTSC/PAL Monitor

You're looking at the two best autosync video scan converters available anywhere. Both can turn your high-resolution desktop workstation, PC or Mac presentations into broadcast-quality videos. The 9400JR is built for the same top performance and excellent picture quality as our top-of-the-line unit. It is the most affordable true broadcast-quality scan converter made. The 9700XL, built for absolute control and flexibility, is the most powerful scan converter made. Period.

9400JR

9700XL



To see all of the powerful features, call for your free demo today.

Folsom™ RESEARCH

526 East Bidwell Street
Folsom, CA 95630-3119
Tel (916)983-1500
Fax (916)983-7236
Email: sales@folsom.com
http://www.folsom.com

SEE US AT SIGGRAPH
BOOTH #1757

For More Information Circle No. 652

TECH BRIEFS

July 1997 • Vol.21 No.7

Features

Briefs

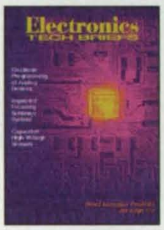
Departments

These empty plastic milk jugs are on their way to becoming a lightweight insulation for rescue blankets and clothing. NASA's Ames Research Center worked with researchers at S.D. Miller & Associates of Flagstaff, AZ, to develop a metal spacecraft insulation using a new honeycomb structure that is more efficient than fibers. A commercialized version of the insulation, made of the recycled plastic jugs, provides four times the warmth of wool, even when wet. For more information, see Mission Accomplished on page 20.

Photo courtesy of NASA Ames

Contents *continued*

Special Supplement



Electronics Tech Briefs

Follows page 64 in selected editions only.

On the cover:

Data visualization software illustrates complex 2D and 3D fluid flow and heat transfer problems. These pressure contours on an impeller in a crystallizer were visualized with AVS/Express Version 3.1 from Advanced Visual Systems of Waltham, MA. The ribbons illustrate the flow around the impeller. See New on Disk on page 89 for information on this and other new software.

Image courtesy of AEA Technology plc and Advanced Visual Systems

NASA Tech Briefs, ISSN 0145-319X, USPS 750-070, copyright © 1997 in U.S. is published monthly by Associated Business Publications Co., Ltd., 317 Madison Ave., New York, NY 10017-5391. The copyright information does not include the (U.S. rights to) individual tech briefs that are supplied by NASA. Editorial, sales, production, and circulation offices at 317 Madison Ave., New York, NY 10017-5391. Subscription for non-qualified subscribers in the U.S., Panama Canal Zone, and Puerto Rico, $75.00 for 1 year; $135 for 2 years; $200.00 for 3 years. Single copies $10.00. Foreign subscriptions one-year U.S. Funds $195.00. Remit by check, draft, postal, express orders or VISA, MasterCard, and American Express. Other remittances at sender's risk. Address all communications for subscriptions or circulation to NASA Tech Briefs, 317 Madison Ave., New York, NY 10017-5391. Second-class postage paid at New York, NY and additional mailing offices.

TECH BRIEFS

BPA ABP

Published by ..... **Associated Business Publications**
President/Chief Executive Officer ..... **Bill Schnirring**
Publisher ..... **Joseph T. Pramberger**
Chief Editor ..... **Linda L. Bell**
Editor, Market Focus Editions ..... **Robert Clark**
Production Manager ..... **Margery Koen**
Assistant Production Manager ..... **John Iwanciw**
Art Director ..... **Lois Erlacher**
Production Artist ..... **Christopher Coleman**
Circulation Manager ..... **Lori Ramos**
Assistant to Reader Service Manager ..... **Damiana Garcia**

BRIEFS & SUPPORTING LITERATURE: Written and produced for NASA by
Advanced Testing Technologies, Inc., Hauppauge, NY 11788
Technical/Managing Editor ..... **Ted Selinsky**
Sr. Technical Analyst ..... **Dr. Larry Grunberger**
Art Manager ..... **Eric Starstrom**
Staff Writers/Editors ..... **Dr. Theron Cole, George Watson, Howard Falk, Gail Pyke**
Graphics ..... **Robert Simons**
Editorial & Production ..... **Joan Schiemann, Caroline Weaver Becky D. Bentley**

NASA:
NASA Tech Briefs are provided by the National Aeronautics and Space Administration, Technology Transfer Division, Washington, DC:
Administrator ..... **Daniel S. Goldin**
Director, Commercial Technology ..... **Dr. Robert Norwood**
Publications Director ..... **Carl Ray**

ASSOCIATED BUSINESS PUBLICATIONS
317 Madison Avenue, New York, NY 10017-5391
(212) 490-3999 FAX (212) 986-7864
President/Chief Executive Officer ..... **Bill Schnirring**
Executive Vice President/Chief Operating Officer ..... **Domenic A. Mucchetti**
Treasurer ..... **Joseph T. Pramberger**
Credit/Collection ..... **Felecia Lahey**
Staff Accountant ..... **Larry Duze**
Budget Analyst ..... **Mark Stanovic**
Accounting Assistant ..... **Alfredo Vasquez**
Director of Marketing/New Business Development ..... **George L. DeFeis**
Exhibition Sales Manager ..... **Wayne Pierce**
Exhibition Sales Representative ..... **Joanna Lipton**
Human Resources Manager ..... **Lourdes Del Valle**
MIS Manager ..... **Ted Morawski**
Webmaster ..... **Albert Sunseri**
Assistant MIS Manager ..... **Pak Tong**
Network Administrator ..... **Dmitry Master**
Office Manager ..... **Sylvia Valentin**
Mailroom Operations ..... **John Torres, Rose D'Addozio**
Administrative Assistant ..... **Christine Saluzzi**

NASA TECH BRIEFS **ADVERTISING ACCOUNT EXECUTIVES**
Headquarters ..... (212) 490-3999
NY, NJ (Area Code 201), Eastern Canada ..... **John Waddell** at (212) 490-3999
PA, DE, NJ (Area Code 908, 609), VA, DC, MD, WV ..... **Tara Morie** at (610) 640-3118
Eastern MA, NH, ME, RI ..... **Paul Gillespie** at (508) 429-8907 **Bill Doucette** at (508) 429-9861
Western MA, CT, VT ..... **George Watts** at (802) 824-5546
Southeast, South Central ..... **Thomas E. Duffy** at (770) 844-7996
OH, MI, IN, KY ..... **Louise Clemens** at (216) 397-7477
IL, WI, MO, IA, MN, ND, SD, NE, KS, Central Canada ..... **Paul Tucker** at (773) 296-2040
N. Calif., CO ..... **Bill Hague** at (408) 492-9292
WA, OR, ID, MT, WY, UT, Western Canada ..... **Bill Madden; Bill Hague** at (253) 858-7575
S. Calif., AZ, NM, NV (For *NASA Tech Briefs*) ..... **Blake Dahlgren** at (310) 288-0391
S. Calif., AZ, NM, NV (For *Electronics and Laser Tech Briefs*) ..... **Richard Ayer Jane Hayward** at (714) 366-9089
TechDeck Postcard Sales ..... **Janet Krebs** at (773) 296-2040

How To Reach Us On Line
NASA Tech Briefs home page: http://www.nasatech.com
Letters to the editor: ntb_edit@mindspring.com
To find out about advertising opportunities: ntb_advertise@mindspring.com

The Mac OS Report

Number two in a series—the facts about Mac OS 8

Mac® OS 8 is coming. It will give you, and millions of other Macintosh® users, a whole new way of working.

It will give your Apple® Macintosh computer (or, for that matter, any other Mac OS computer of your choice) a dramatic new look and feel, along with all kinds of enhanced capabilities for accessing the Internet.

It will also set an entirely new standard of powerful, intuitive computing—a standard the competition can try to catch up to. (Again.)

A new way of working

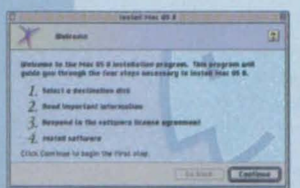
The moment you start using Mac OS 8, you'll feel the difference: you'll find yourself accomplishing more in less time. A multi-threaded Finder™ lets you execute multiple tasks simultaneously, such as launching applications and copying files. Mac OS 8 includes new information-management tools, such as contextual pop-up menus and spring-loaded folders, that give you quicker and easier access to all your information. A scalable environment lets you either limit your menu and window options, or expand them—whichever works better for you. A new, dimensional look makes the interface more dynamic and engaging than ever. And Mac OS 8 also includes the latest versions of QuickTime® with its MPEG support,

QuickTime VR and QuickDraw® 3D.

How easy is it to get going with all these new technologies and features? Very. Because our new installer and setup assistants take you through each step of configuring your new system software. Once you're up and running, PowerPC™-native code improves your performance. Mac OS 8 is also completely compatible with all PowerPC and 68040-based hardware and software.

A new way of accessing the Internet

Mac OS 8 includes TCP/IP and PPP for easy network or modem access direct from the Finder. You get Netscape Navigator,™ Microsoft® Internet Explorer™ and the PointCast Network.™ And a new Internet Setup Assistant makes it easier than ever to get on the Net, whether you're doing it from home with a modem or from work with a high-speed connection. Personal web sharing is standard, so you



can turn any Mac into an Internet web server. And Java™ support is built in, so you can run Java applications just as though they were any other desktop applications. (If you were wondering, Windows® 95 can't do this.)

And more advancements are on the way

Mac OS 8 is one of the most significant advances in OS technology ever. And it's just the beginning—additional upgrades are planned. And our support for the Mac OS will continue for years.

At the same time, we're also working on an industrial-strength OS, code-named Rhapsody, that will offer features such as protected memory, preemptive multitasking and symmetric multiprocessing. Rhapsody will also provide backwards compatibility, so you can be sure that the vast majority of your Mac OS apps will run on Rhapsody, too.

In other words: Apple is still developing the most innovative, user-friendly and consistently superior products on the market. That's one part of our system that won't change. To learn more, visit www.macos.apple.com.

N

If you want to use Netscape Navigator to browse the Net, you'll like this: it's an integrated part of Mac OS 8.

Microsoft® Internet Explorer

Microsoft Internet Explorer fans will be happy to know that this powerful web browser is also built right in. Choice is just one of the many Mac OS 8 mottos.

PointCast

It's the PointCast Network. It comes with Mac OS 8. And it grabs the news you want directly off the Net to create customized desktop news pages. Daily. Hourly. As often as you want.

JAVA Authorized Licensee

When you get Mac OS 8, you also get built-in Java support, so you can run both local and network-based Java software just like other desktop applications.

Mac OS

Mac OS has always been the easiest and most intuitive of all operating systems. Now, Mac OS 8 brings this kind of computing to a whole new level.

NASA Commercial Technology Team

NASA's R&D efforts produce a robust supply of promising technologies with applications in many industries. A key mechanism in identifying commercial applications for this technology is NASA's national network of commercial technology organizations. The network includes ten NASA field centers, six Regional Technology Transfer Centers (RTTCs), the National Technology Transfer Center (NTTC), business support organizations, and a full tie-in with the Federal Laboratory Consortium (FLC) for Technology Transfer. Call (206) 683-1005 for the FLC coordinator in your area.

NASA's Technology Sources

If you need further information about new technologies presented in *NASA Tech Briefs*, request the Technical Support Package (TSP) indicated at the end of the brief. If a TSP is not available, the Commercial Technology Office at the NASA field center that sponsored the research can provide you with additional information and, if applicable, refer you to the innovator(s). These centers are the source of all NASA-developed technology.

Ames Research Center
Selected technological strengths: Fluid Dynamics; Life Sciences; Earth and Atmospheric Sciences; Information, Communications, and Intelligent Systems; Human Factors.
Bruce Webbon
(415) 604-6646
bwebbon@mail.arc.nasa.gov

Dryden Flight Research Center
Selected technological strengths: Aerodynamics; Aeronautics Flight Testing; Aeropropulsion; Flight Systems; Thermal Testing; Integrated Systems Test and Validation.
Lee Duke
(805) 258-3802
duke@louie.dfrf.nasa.gov

Goddard Space Flight Center
Selected technological strengths: Earth and Planetary Science Missions; LIDAR; Cryogenic Systems; Tracking; Telemetry; Command.
George Alcorn
(301) 286-5810
galcorn@gsfc.nasa.gov

Jet Propulsion Laboratory
Selected technological strengths: Near/Deep-Space Mission Engineering; Microspacecraft; Space Communications; Information Systems; Remote Sensing; Robotics.
Merle McKenzie
(818) 354-2577
merle.mckenzie@ccmail.jpl.nasa.gov

Johnson Space Center
Selected technological strengths: Artificial Intelligence and Human Computer Interface; Life Sciences; Human Space Flight Operations; Avionics; Sensors; Communications.
Hank Davis
(713) 483-0474
hdavis@gp101.jsc.nasa.gov

Kennedy Space Center
Selected technological strengths: Environmental Monitoring; Sensors; Corrosion Protection; Bio-Sciences; Process Modeling; Work Planning/Control; Meteorology.
Gale Allen
(407) 867-8035
galeallen-1@ksc.nasa.gov

Langley Research Center
Selected technological strengths: Aerodynamics; Flight Systems; Materials; Structures; Sensors; Measurements; Information Sciences.
Dr. Joseph S. Heyman
(804) 864-6006
j.s.heyman@larc.nasa.gov

Lewis Research Center
Selected technological strengths: Aeropropulsion; Communications; Energy Technology; High Temperature Materials Research.
Ann Heyward
(216) 433-3484
ann.o.heyward@lerc.nasa.gov

Marshall Space Flight Center
Selected technological strengths: Materials; Manufacturing; Nondestructive Evaluation; Biotechnology; Space Propulsion; Controls and Dynamics; Structures; Microgravity Processing.
Harry Craft
(205) 544-5419
harry.craft@msfc.nasa.gov

Stennis Space Center
Selected technological strengths: Propulsion Systems; Test/Monitoring; Remote Sensing; Nonintrusive Instrumentation.
Kirk Sharp
(601) 688-1929
ksharp@ssc.nasa.gov

NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D and foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the Regional Technology Transfer Center nearest you, call (800) 472-6785.

Dr. David Moran
National Technology Transfer Center
(800) 678-6882

Ken Dozier
Far-West Technology Transfer Center
University of Southern California
(213) 743-2353

Dr. William Gasko
Center for Technology Commercialization
Massachusetts Technology Park
(508) 870-0042

J. Ronald Thornton
Southern Technology Applications Center
University of Florida
(904) 462-3913

Gary Sera
Mid-Continent Technology Transfer Center
Texas A&M University
(409) 845-8762

Lani S. Hummel
Mid-Atlantic Technology Applications Center
University of Pittsburgh
(412) 383-2500

Chris Coburn
Great Lakes Industrial Technology Transfer Center
Battelle Memorial Institute
(216) 734-0094

NASA ON-LINE: Go to NASA's Commercial Technology Network (CTN) on the World Wide Web at **http://nctn.hq.nasa.gov** to search NASA technology resources, find commercialization opportunities, and learn about NASA's national network of programs, organizations, and services dedicated to technology transfer and commercialization.

NASA Program Offices

At NASA Headquarters there are seven major program offices that develop and oversee technology projects of potential interest to industry. The street address for these strategic business units is: NASA Headquarters, 300 E St. SW, Washington, DC 20546.

Carl Ray
Small Business Innovation Research Program (SBIR) & Small Business Technology Transfer Program (STTR)
(202) 358-4652
cray@mail.hq.nasa.gov

Dr. Robert Norwood
Office of Aeronautics and Space Transportation Technology (Code R)
(202) 358-2320
rnorwood@mail.hq.nasa.gov

Philip Hodge
Office of Space Flight (Code M)
(202) 358-1417
phodge@osfms1.hq.nasa.gov

Gerald Johnson
Office of Aeronautics (Code R)
(202) 358-4711
g_johnson@aeromail.hq.nasa.gov

Bill Smith
Office of Space Sciences (Code S)
(202) 358-2473
wsmith@sm.ms.ossa.hq.nasa.gov

Bert Hansen
Office of Microgravity Science Applications (Code U)
(202) 358-1958
bhansen@gm.olmsa.hq.nasa.gov

Granville Paules
Office of Mission to Planet Earth (Code Y)
(202) 358-0706
gpaules@mtpe.hq.nasa.gov

NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint sponsored research agreements and incubate small start-up companies with significant business promise.

Karen Robbins
American Technology Initiative
Menlo Park, CA
(415) 325-5353

Dr. Jill Fabricant
Johnson Technology Commercialization Center
Houston, TX
(713) 335-1250

Joe Boeddeker
Ames Technology Commercialization Center
San Jose, CA
(408) 557-6799

Dan Morrison
Mississippi Enterprise for Technology
Stennis Space Center, MS
(800) 746-4699

If you are interested in information, applications, and services relating to satellite and aerial data for Earth resources, contact: Dr. Stan Morain, **Earth Analysis Center,** (505) 277-3622. For software developed with NASA funding, contact the **Computer Software Management and Information Center (COSMIC)** at phone: (706) 542-3265; Fax: (706) 542-4807; E-mail: http://www.cosmic.uga.edu or service@cosmic.uga.edu.

WHITE WATER.

AN ADRENALINE RUSH

FOR KAYAKERS.

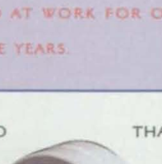
ABSOLUTE HELL

FOR BEARINGS.

FOR YEARS AT INLAND PAPERBOARD AND PACKAGING, INC'S CORRUGATING MEDIUM MILL IN NEWPORT, INDIANA, A TREACHEROUS STRETCH OF WHITE WATER WAS SENDING BEARINGS TO A WATERY GRAVE. CONTINUALLY BATHED IN CORROSIVE LIQUID, THE BEARINGS ON WIRE RETURN ROLLS WERE FAILING AT A RATE OF ONE EVERY FOUR MONTHS. THIS LED TO DAMAGE IN THE WIRE RETURN ROLLS, CAUSING THEM TO REQUIRE FREQUENT CHANGING. QUITE AN EXPENSIVE PROBLEM.

THAT'S WHEN A CRACK TEAM OF TORRINGTON ENGINEERS WAS CALLED IN. THEY RECOMMENDED TDC™ (THIN DENSE CHROME) TO COMBAT THE RUST-LOVING WHITE WATER. TDC-COATED BEARINGS PROVIDE SUPERIOR PERFORMANCE AND RESIST RUST AND CORROSION, EVEN IN THE HARSHEST ENVIRONMENTS. JUST WHAT INLAND NEEDED. THEY INSTALLED TDC BEARINGS ON THEIR WIRE RETURN ROLLS TO PUT THEM TO THE TEST.

> IN CORROSIVE WHITE WATER THAT RUINS ORDINARY BEARINGS IN ONLY FOUR MONTHS, TDC BEARINGS HAVE BEEN HARD AT WORK FOR OVER THREE YEARS.



THE TDC BEARINGS SUCCEEDED FAR BEYOND INLAND'S EXPECTATIONS. IN FACT, AFTER MORE THAN THREE YEARS IN SERVICE, THEY'VE YET TO REPLACE A SINGLE ONE. INLAND IS SO PLEASED THAT THEY'RE NOW USING TDC IN THEIR FELT ROLL POSITIONS AS WELL. THEY ESTIMATE THAT TORRINGTON TDC SAVES THE MILL OVER $100,000 A YEAR.

SETTING NEW STANDARDS IN BEARING PERFORMANCE AND RELIABILITY IS ALL IN A DAY'S WORK FOR THE PEOPLE AT TORRINGTON. WE'RE CONTINUALLY DEVELOPING INNOVATIVE SOLUTIONS TO HELP OUR CUSTOMERS THRIVE UNDER EVEN THE MOST ADVERSE CONDITIONS.

THE TORRINGTON COMPANY. WHATEVER IT TAKES. INCLUDING CHURNING WHITE WATER.

TORRINGTON
INGERSOLL-RAND
www.torrington.com

Vespel® parts can handle some of the toughest jobs.

Like paying for themselves.

Everyone knows that Vespel® polyimide parts improve performance in severe service applications by withstanding extreme heat, friction, pressure and contamination – with minimal or no lubrication. But now manufacturers who use Vespel parts in general applications are beginning to notice improvements somewhere else: *the bottom line*. That's because the reliability and long life of Vespel parts can make them the most cost-effective choice for general applications in the long term.

If your applications require parts that can withstand extreme temperatures (-350°F to 550°F), Vespel should be your first choice. Vespel should

http://www.dupont.com/enggpolymers/americas

Insulators. *In plasma-arc cutting torches, Vespel insulators provide superior strength and durability at high temperatures up to 550°F, lasting up to six times longer than fragile ceramic insulators.*

Seal Rings. *In the assembly of automobile transmissions, Vespel seal rings reduce costs by replacing expensive metal rings, which can fracture or deform during assembly. They also reduce warranty costs by producing a better seal.*

Thrust Washers. *In farm tractor transmissions, Vespel thrust washers reduce costs and manufacturing time by eliminating the need for secondary machining. Vespel washers also exhibit high performance and low wear with limited or no lubrication.*

Bearings. *In photocopiers, Vespel composite idler gear hub bushings are a cost-effective alternative to metal. The Vespel parts provide ultra-high temperature resistance and dimensional stability while offering a low coefficient of friction, as well as long life without lubrication.*

Bushings. *In aircraft engine vanes, Vespel bushings withstand high-frequency vibration dithering and offer excellent stability and lubricity at high temperatures. They also reduce assembly time.*

Wear Strips. *In textile equipment, Vespel tenter frame clip wear strips reduce costs by eliminating the need for lubrication. They also improve textile manufacturing quality by eliminating oil contamination, and provide good wear and temperature resistance.*

also be considered if you have parts that rub together, if metal parts are too noisy, or if fluid flow needs to be controlled.

Superior strength and reliability aren't the only ways Vespel can save you money. Often, you can consolidate two or more existing parts in one Vespel piece.

IF YOU WANT TO GET TECHNICAL

For information, call 1-800-426-7246. Or write: DuPont Vespel® Product Information Center, P.O. Box 1138, Bloomfield Hills, MI 48303-1138.

And Vespel parts can be direct-formed, which eliminates machining costs.

When you consider how cost-effective Vespel parts can be in the long term, it's clear that we don't just make better bushings, bearings, washers and seals. *We make better sense.*

DUPONT

Vespel®
Only by DuPont

For More Information Circle No. 530

Notebook

TSPs Go Digital

This month we are introducing an exciting new service for our readers. Technical Support Packages (TSPs), which provide more information about the innovations described in tech briefs, now are available on-line at the *NASA Tech Briefs* web site — www.nasatech.com. Simply click on the TSP button on the home page and follow the prompts to view and download as many packages as you would like at no charge (U.S. only).

This issue's TSPs are "up" now, and future issues will be added to create a six-month rotating inventory. Packages from prior issues — those dating back more than six months — will be archived and available from the National Technology Transfer Center in Wheeling, WV.

You still can receive paper copies of TSPs via standard mail by completing the "TSP Order Card" bound in the magazine. To help recover costs, there now is a modest $5.00 postage and handling fee for each hard-copy TSP. Use the "Free Information Request Card" for all other editorial and advertising inquiries. For quicker service, use the new fax form on page 81.

Share Your Ideas On-line

We invite you to explore the many other new features of the *NASA Tech Briefs* web site. For starters, you can subscribe or renew your subscription electronically, post questions and share ideas in the new on-line Reader Forum, and preview highlights of upcoming issues. You also can learn about NASA's nationwide network of R&D centers and connect to their web sites, search NASA patent abstracts, and locate vendors and services in the "Hot Products" section.

Moreover, you can get complete details about the *NASA Tech Briefs*-sponsored Technology 2007 conference coming to Boston's Hynes Convention Center September 22-24, and obtain papers from last year's event.

There's much more to come, including a "Career Opportunities" section where readers will be able to post positions wanted, scan offerings from major companies, and get expert advice.

Please give us your comments and suggestions for the web site and magazine when you sign our guest book, the first option you will see when you hit the home page. Our goal is to make *NASA Tech Briefs* as relevant as possible to your needs and interests. I personally read every feedback card and on-line comment you send — with this goal in mind — so please keep them coming.

Joseph Pramberger
Publisher
joe@abptuf.org

NASA NEWS BRIEFS

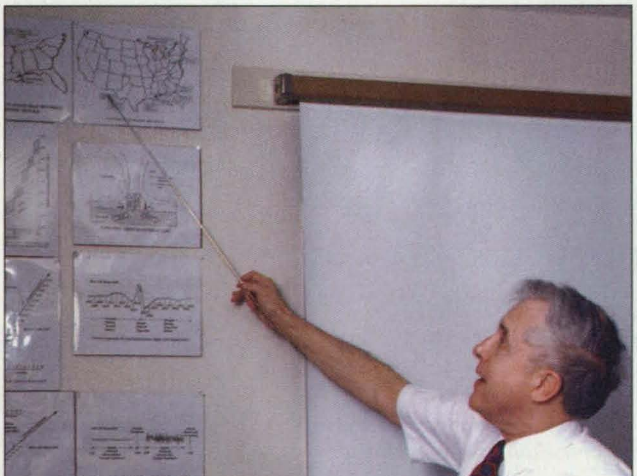
Five project teams from NASA's Ames Research Center with technologies deemed to have commercial spinoff potential to private industry recently were awarded funding of up to $75,000 each under the Commercial Technology Projects Fund (CTPF) program.

- The Thermoelectrically Cooled Diode Laser Spectrometer for a 13C/12C Medical Breath Test (project led by Glenn C. Carle) will be used in patient breath tests to provide medical diagnostic information about organs such as the liver and stomach.
- Environment for Computational Intelligence (project led by Dr. Silvano Colombano) includes several features for combining fuzzy control with reinforcement learning, a neural network technology for automatic learning in difficult environments.
- The Remote Sensing Support for Wine-Grape Harvest project (led by David L. Peterson) is expected to help increase wine production efficiency through improved planning and deployment of field-sampling personnel.
- Robotic Neurosurgery Leading to Multimodality Devices for Tissues Identification (project led by Dr. Robert W. Mah) will improve diagnostic accuracy and make surgery more precise. Robotic neurosurgery also could be controlled remotely.
- The VRML-Based Remote Science Visualization Tools project (led by Dr. Michael H. Sims) will develop a remote science visualization software prototype that can run on low-cost computer workstations, enabling widespread use in the science and technical communities.

For more information on the CTPF program, contact Robert Callaway of Ames Research Center at 415-604-0039.

Tornadoes can strike anywhere at any time of the day or night. While those that occur during daylight hours can be seen a mile or so away on the ground, there often is little or no warning of tornadoes spawned from storms at night. Research conducted at NASA's Marshall Space Flight Center could make possible an accurate tornado warning system for homes and communities.

The Marshall research involved calculating turbulent pressure fluctuations on the surface of the space shuttle during atmospheric flight. The fluctuations produced noise and vibrations inside the shuttle. Dr. Frank Tatom, president of Engineering Analysis of Huntsville, AL, completed a study for the Department of Commerce's National Oceanic and Atmospheric Administration that used the Marshall research, which prompted Tatom "to examine the possibility that turbulent pressure fluctuations inside a tornado in contact with the ground should produce seismic waves."



Dr. Frank Tatom explains the research that has gone into developing his seismic tornado detection and warning system.

If these vibrations can be isolated and identified, a warning system for tornadoes in contact with the ground — tuned to that frequency range and combined with appropriate filters — should be feasible, Tatom concluded. He has developed two types of concept instruments using his company's funds: one is a network warning system with 20 or more sites that would be linked to city or county emergency centers and would be used in conjunction with Doppler radar; the other is a residential model for homes and workplaces that would be linked to a home alarm system — similar to a smoke detector but with a different type of signal to distinguish between the two.

For more information, contact Bob Lessels of Marshall Space Flight Center's Technology Transfer Office at 205-544-6539; fax: 205-544-3278.

Johns Hopkins University's School of Medicine in Baltimore, MD, and Applied Physics Technology of Laurel, MD, have teamed with NASA's Johnson Space Center to form a new institute to study the medical risks and needs of people on long-term space missions. The National Space Biomedical Research Institute, led by Baylor School of Medicine in Houston, TX, began operation on June 1 with a five-year, $50 million contract that could be extended to 20 years and $145 million.

The Institute, sponsored by NASA Johnson, will be the focal point of NASA-sponsored biomedical research for supporting long-term human exploration of space. The work also will enhance the quality of life on Earth by applying advances in human knowledge and technology acquired from living and working in space.

Other members of the Institute's consortium are Harvard Medical School and the Massachusetts Institute of Technology (MIT), both of Cambridge, MA; Morehouse School of Medicine in Atlanta, GA; Rice University in Houston, TX; and Texas A&M University in College Station, TX. As the Institute's sponsor, NASA Johnson will make available to the consortium NASA's expertise in biomedical research and space flight and the associated facilities and assets developed over more than 30 years of human space flight.

For more information, contact Ben Walker of Johns Hopkins University/Applied Physics Laboratory's Office of Communications and Public Affairs at 301-953-6792; e-mail: ben.walker@jhuapl.edu.

After 20 years of research and development, the tiltrotor aircraft is poised to enter commercial service. The tiltrotor combines the speed and range of a turboprop airplane with the vertical takeoff and landing capability of a helicopter. In May, NASA's Ames Research Center, which manages NASA's Short Haul Civil Tiltrotor program, marked the 20th anniversary of the first flight of the XV-15 Tiltrotor Research Aircraft, the first proof-of-concept tiltrotor aircraft.

In July 1999, Bell Helicopter Textron of Forth Worth, TX, and Boeing Defense and Space Group's Helicopters Division in Philadelphia, PA, plan to conduct the first flight of a civilian tiltrotor, the Bell-Boeing 609, a nine-passenger executive transport aircraft. The world's first production tiltrotor, the V-22 Osprey, is being built as a military aircraft that will carry 24 combat-ready troops. Both the 609 and the V-22 are direct descendants of the XV-15, developed under a joint NASA/Army/Bell program at Ames.

Tiltrotor technology has been one of the most successful aeronautics research programs in NASA history, according to William J. Snyder, manager of the Advanced Tiltrotor Transport Technology Office at Ames. The XV-15 is still flying at Bell Helicopter Textron's flight center in Arlington, TX. The aircraft had a 15-year career in flight research at Ames before being sent to Bell in 1994 for further research.

NASA Ames is continuing its work on the tiltrotor concept with studies on the development of a 40-passenger civil tiltrotor, which the Department of Transportation has judged to be technically, economically, and environmentally feasible.

For more information, contact Mike Mewhinney of NASA's Ames Research Center at 415-604-3937; e-mail: mmewhinney@mail.arc.nasa.gov.

NASA, represented by Marshall Space Flight Center, and the National Fire Protection Association (NFPA) have signed an agreement to transfer technologies derived from the space program to improve safety for firefighters and the public. All ten NASA field centers will participate. The NFPA will provide consultation to support work already underway at Marshall with several fire departments. The project will continue through the year 2002.

A working group chaired by Chris Bramon of Marshall will target ten specific areas for investigation and research, including: developing a structural integrity monitor that could anticipate the collapse of burning buildings; designing a personnel locator system, enabling a central site to know the presence and location of emergency services personnel; developing a vehicle-mounted transponder package to track vehicles carrying hazardous materials; and developing a vital signs monitor and transmitter to be worn by emergency services personnel operating in extreme conditions with high heat, smoke, dangerous chemicals, and stress.

The XV-15 Tiltrotor Research Aircraft made its first flight 20 years ago at the Bell Helicopter Textron flight test center. It is still used for research flight testing and evaluation of new tiltrotor applications.

Other products the group seeks to develop include advanced materials for fire suits that would protect against exposure to both hazardous chemicals and flash fires; an urban search and rescue emitter to be worn by citizens in earthquake-prone areas; a thermal sensing system for installation in new construction that will detect fires hidden in walls and other inaccessible areas; a helmet that can be worn inside an encapsulated suit to provide heads-up information, personal communications, and a control capability; and a remote sensor to determine the temperature of a standing wall without touching the surface by hand. Providing on-the-spot identification of unknown materials that may present a hazard to emergency services personnel also is on the list of the group's priorities.

For more information, contact Bob Lessels of Marshall's Technology Transfer Office at 205-544-6539; fax: 205-544-3278.

The Elmer A. Sperry Award, recognizing a distinguished engineering contribution that has advanced the art of transportation, was presented recently to Thomas G. Butler (in memoriam) and Richard H. MacNeal for the development of the NASA Structural Analysis (NASTRAN) program. The award is sponsored by six professional engineering organizations: The American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the Society of Automotive Engineers, the Society of Naval Architects and Marine Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Civil Engineers.

Butler, an engineer at NASA's Goddard Space Flight Center, was the innovator of NASTRAN in the 1960s. MacNeal led his company, the MacNeal-Schwendler Corporation, in programming and implementing the software for public release. When launched in 1970, NASTRAN introduced thousands of engineers to a new dimension of mathematical precision in evaluating stress in complex structures. The finite element analysis tool mathematically solves large, complex structural analysis problems in engineering disciplines such as transportation, contributing to lighter and stronger aircraft, spacecraft, ships, and cars. MacNeal-Schwendler secured the rights to market subsequent versions of NASTRAN in 1982.

For more information on the awards, contact Anne Buckley of the American Society of Mechanical Engineers (ASME) International at 212-705-8157; e-mail: buckleya@asme.org.

Mission Accomplished

NASA's research into the development of lightweight metal insulation for spacecraft has led to a spinoff product through the agency's Small Business Innovation Research (SBIR) program. Under a Phase I SBIR contract with NASA's Ames Research Center, S.D. Miller & Associates, Flagstaff, AZ, has developed a new honeycomb structure that is more efficient than fibers for insulation and will be made from metals for high-temperature uses. Plastic insulation also can be made from materials such as recycled milk bottles.

This breakthrough material is four times warmer than wool in cold and damp conditions.

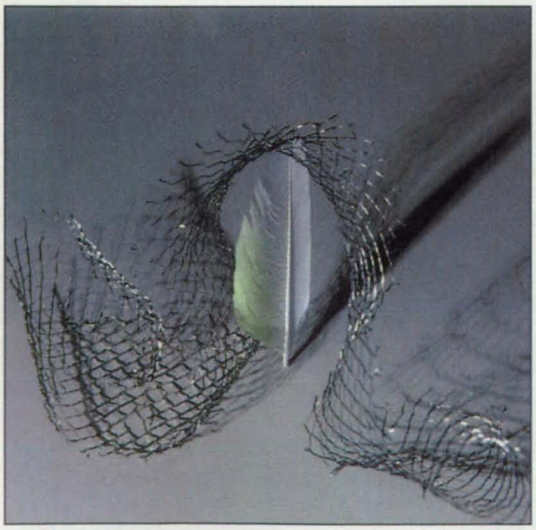
Working with Ames scientists, researchers have created a lightweight plastic insulation for blankets and clothing that is deemed to be better than wool. Like wool, the material can keep a person warm, even when it is wet. Principal investigator Steve Miller said that "the blankets are better than wool or fleece because they are non-allergenic and they dry five times faster. The new material is also four times warmer than wool in cold and damp conditions." Miller said that his company plans to work with ambulance companies and Red Cross chapters to evaluate the use of the blankets. Currently, 250 of the blankets are being evaluated for use in emergencies by Ames' Disaster Assistance and Rescue Team.

"This could be a breakthrough material for spacecraft insulation," said Dr. Susan White, a materials scientist acting as NASA's technical representative for the SBIR contract. Metal honeycomb insulation used on future spacecraft could significantly reduce launch weight and launch costs, according to Miller.

The lightweight plastic insulation, when used in clothing, can keep a person warm, even when it is wet, and is non-allergenic.

S.D. Miller recently was awarded a Phase II, two-year, $600,000 SBIR contract to work with Ames scientists and other research institutions to demonstrate the insulation efficiency of the new material to more than 1093°C. In keeping with SBIR program goals, the new insulation technology would be commercialized without government financial support. Production of rescue blankets may result in 15 new jobs, said Miller, and 70 new jobs to make the spacecraft insulation.

For more information, contact Dr. Susan White of NASA Ames at 415-604-6617; e-mail: swhite@mail.arc.nasa.gov; or Steve Miller of S.D. Miller & Associates at 520-779-2056; e-mail: s.miller@flaglink.com.



Incorporating the same honeycomb concept used to manufacture metallic spacecraft insulation (left), a new structure was designed for the manufacture of plastic insulation made of recycled plastic milk jugs. The plastic insulation is used in rescue blankets (right).

Backup 64 GB An Hour To The Strongest Tape Ever Made

Plug Compatible With

Alliant
Alpha Micro
Altos
Amdahl
Apollo
Arix
AT&T
Basic-4
Bull
Concurrent
Convergent
Data General
Digital
Gould/Encore
Harris
Honeywell
HP
IBM PC/Compatible
IBM Midrange/Mainframe
ICL
Intergraph
Macintosh
McDonnell Douglas
Motorola
NCR
NeXT
Novell
Pertec
Prime
Pyramid
Sequent
Silicon Graphics
Stratus
Sun
Texas Instruments
Unisys
Ultimate
Wang
Windows NT

Let's face it, your backup is only as good as your tape. And all the performance in the world won't get your data back if your tape is weak or dirty. Fortunately, there's no need to compromise. The CY-8000 is the safest, the most reliable, *and the fastest* 8mm tape drive on the market.

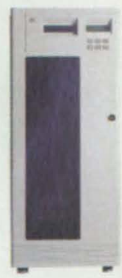
Compact in size, the CY-8000 can store up to 125 GB on each tape.

The CY-8000 uses ***Advanced Metal Evaporated*** media, a 100% cobalt, 2-layer tape that features a diamond-like coating for exceptional durability. And it's the *only* 8mm drive with a ***built-in head cleaner*** to keep the tape path free of contaminants, further ensuring data integrity and virtually eliminating the time and expense associated with cleaning kits.

In addition to superior design, the CY-8000 offers unbeatable performance. Able to store ***25 GB at 3 MBS***, uncompressed, you can achieve up to ***125 GB at 9 MBS*** with optional data compression. With 257% more capacity and 500% greater speed* than industry standard 8mm drives, the CY-8000 can backup faster to fewer tapes.


The superior design of the AME tape makes it suitable for 20,000 passes.

For maximum flexibility, our exclusive Advanced SCSI Processor option provides five recording modes — ***striping, mirroring, cascade, independent,*** and ***offline copy/verify***. So you can easily make duplicate tapes for off-site storage or data exchange, build fault tolerance, or simply maximize performance to accomplish bigger backups in less time. With the Advanced SCSI Processor, you've got a complete data storage management tool.


Automate access to up to six drives and 126 tapes with our intelligent tape library.

Available in a single or multi-drive desktop, rack mount, or library configuration, the CY-8000 is scalable to ***15.75 terabytes***. If you need to ensure the safety of your company's critical data, don't trust anything less.

** Uncompressed; CY-8000 performance advantages are even more impressive with data compression.*

(757) 833-9000

CYBERNETICS

111 Cybernetics Way • Yorktown, VA 23693 • Fax (757) 833-9300

Early space shuttles were plagued by the loss of protective tiles during reentry, a serious problem since losing too many tiles could cause the shuttle to burn up on reentry. An investigation by NASA's Johnson Space Center determined that the glues used to hold the tiles in place were modified chemically by reactive gases while the shuttle was in low-Earth orbit. New materials were tested that solved the problem and led to Flowing Discharge Radical Chemistry (FDRC) changes in surface characteristics. In an exclusive licensing agreement with NASA, FlowGenix, a biomaterials company in Webster, TX, commercialized the FDRC technology and its use for treating various materials such as porous polymers.

Space near Earth is a vacuum that contains oxygen and other reactive gases activated by the Sun. These gases can be produced under Earth conditions but at high energy, which has damaging effects to polymer materials. FlowGenix's breakthrough process produced new "cold" reactive gases that modify surfaces without damage. A gas stream flows under low pressure through a special reactor in FDRC. The reactor's shape and electric design enable a large volume of reactive atoms or molecules, called radicals, to form as gas moves through the plasma zone. The gas cools and becomes more pure as it diffuses away from the zone. The gas thoroughly, but gently, modifies the surfaces it touches, turning a simple material into a high-tech, high-value-added component.

Dr. Jill Fabricant (right), President of FlowGenix, and Dr. Steve Koontz, Director of Research, discuss how a plasma reactor is used in their FDRC process, which produces cold reactive gases that modify surfaces without damage.

FlowGenix initially will focus on biotechnology applications for disposable products to make and purify DNA. The FDRC technology allows DNA synthesis supports, chromatography media, and diagnostic cassettes to be made from inexpensive porous sintered polymer filters, which can be loaded interstitially for biochemical purposes. The products offer greater loading capacities, good dimensional stability, superior flow rates, less reagent utilization, significantly lower costs, and design flexibility. They substantially shorten cycle times for biopharmaceutical production and development. Markets for small- and large-scale synthesis supports and chromatography products are expected to exceed $300 million this year and $900 million by 2001.

For more information, contact Dr. Jill D. Fabricant of FlowGenix at 281-316-1070; e-mail: jfabricant@flowgenix.com; http://www.flowgenix.com.

e x c e l l e n t   q u a l i t y   w o r l d - w i d e

Technical Furnishing under the symbol of the knight.

elidos

miracel

Data management – productive and economic

- **LAN workstations based on elidos:**
  straightforward cabling, easy integration of computers and monitors, height-adjustable worktops, ergonomic and stylish design.
- **19" LAN racks and enclosures:**
  flexible internal structure, high strenght and stability, optimum balance between overall space and useful space, easy assembly and reassembly, neat cabling.

Your LAN Technology – protection and integration in the tradition of the knight.

Take a look at our innovative range of high tech consoles and the multiuse 19" rack miracel:

http://www.knuerr.de

dacobas

The dacobas modular industrial furnishing system provides unlimited flexibility for individual applications. Standard modules facilitate upgrading and future expansion.

miracel

Universal application in all areas is guaranteed by the design of the miracel 19" rack for electronics: a stable lightweight, cost-effective multiuse rack system.

knürr

excellent quality world-wide

NÜRR USA Inc. • 1890 North Voyager Avenue • Simi Valley, CA 93063 • Tel. (8 05) 5 26-77 33 • Fax (8 05) 5 84-83 71
NÜRR USA East • 120 Northpoint Court • Blythewood, SC 29016 • Tel. (8 03) 7 86-26 66 • Fax (8 03) 7 86-24 44

For More Information Circle No. 595

Reader Forum

Reader Forum is devoted to the thoughts, concerns, questions, and comments of our readers. If you have a comment, a question regarding a specific technical problem, or an answer to a question that appeared in a recent issue, send your letter to the address below.

I'm chairman of an agency that services consumers who are mentally retarded or have a developmental disability. We employ many of these consumers in a business that refurbishes rail car seats. Currently, we have a contract to make a permanent impression on vinyl seat covers that looks like a sewn seam. Some equipment we've looked at to do the job costs $20,000 or more. We need a less costly way to do this. Can you refer me to a source that might be able to help us?

Gene Krumm
Board Chair
Allegany ARC
Wellsville, NY

The March Reader Forum included a request from Joseph Hunter for fractal image compression techniques for DOS and/or Windows. There are a number of techniques and software available. The Internet has several news groups dedicated to compression, in which fractal compression is discussed; other Internet sites are dedicated to fractal technology. There are PC-based code/decode packages available with source code. I suggest to Mr. Hunter that an Internet search be his starting point since there are a number of graduate students working to develop better algorithms - direct electronic correspondence with them should provide a positive result.

Harry Hodges
hhodges@
compuserve.com

The March 1995 issue of NASA Tech Briefs *featured a reliability engineering manual available through Lewis Research Center. I purchased the book, which has since aided us in saving a $35 million project by helping us identify and measure the existing system, and recommend appropriate changes.*

Eric Epstein
Director of Engr.,
CBIS
Fairfax, VA

In the May Reader Forum, Alan Lieberman inquired about a source for precision distance measuring equipment. My company, Ultrasonic Arrays (425-481-6611), manufactures non-contact, ultrasonic distance and thickness measuring equipment suitable for industrial and laboratory environments, and which meets Mr. Lieberman's accuracy requirements of ±0.00025".

Paula Gardner
Ultrasonic Arrays
Woodinville, WA

Post your letters to **Reader Forum** on-line at **www.nasatech.com** or send to: Editor, *NASA Tech Briefs*, 317 Madison Ave., Suite 1900, New York, NY 10017; Fax: 212-986-7864. Please include your name, company (if applicable), address, and phone number or e-mail address.

Commercialization Opportunities

Miniature, Low-Power Alphatron

Originally conceived to measure pressure of the Martian atmosphere, this gas-pressure gauge can be adopted for use on Earth to measure atmospheric and subatmospheric gas pressures in scientific and industrial applications in the range of 10^2 to 10^5 Pa. The gauge is rugged and has no moving parts.
(See page 28.)

Removable, Reusable Handle

A detachable handle fits specially designed modular cabinets. There is no need to provide separate handles for each cabinet.
(See page 36.)

Transverse-Mode Electron-Beam Microwave Generator

This vacuum-tube device is superior to a klystron in that its operation does not depend on maintenance of critical voltages, and it can generate a useful amount of power at frequencies above 100 GHz.
(See page 44.)

Improved Ultraviolet-and-Infrared Hydrogen-Flame Detector

An improved detector is not as vulnerable to false alarms as commercial units. It is designed to detect small hydrogen flames, not the large ones that are lit deliberately, and the unit is not readily confused by other sources of light.
(See page 49.)

Heteroepitaxial Growth of Monocrystalline Boron Nitride

A proposed deposition process would grow monocrystalline cubic boron nitride on silicon carbide films. Success of this process may open a way for making new high-temperature, high-power, high-frequency electronic devices.
(See page 65.)

Making InP Solar Cells From Tertiarybutylphosphine

A much less hazardous substitute for phosphine may be used in production of InP films for solar cells. Preliminary findings are optimistic and may lead to mass production of InP solar cells.
(See page 66.)

First Supersonic Yaw-Vectoring Flight for the ACTIVE Program

Yaw-vectoring flights were recently conducted on F-15 aircraft. This design could lead to significant performance improvements in future aircraft, which would include extended range, increased maneuverability, reduced operating cost, and greater safety.
(See page 74.)

Automated Microspectrofluorimeter and Cell-Culture Apparatus

All of the instrumentation needed to culture cells and examine them is contained in one compact package. The instrument is designed to operate under computer control.
(See page 82.)

Special Focus: Mechanical Components

Miniature, Low-Power Alphatron

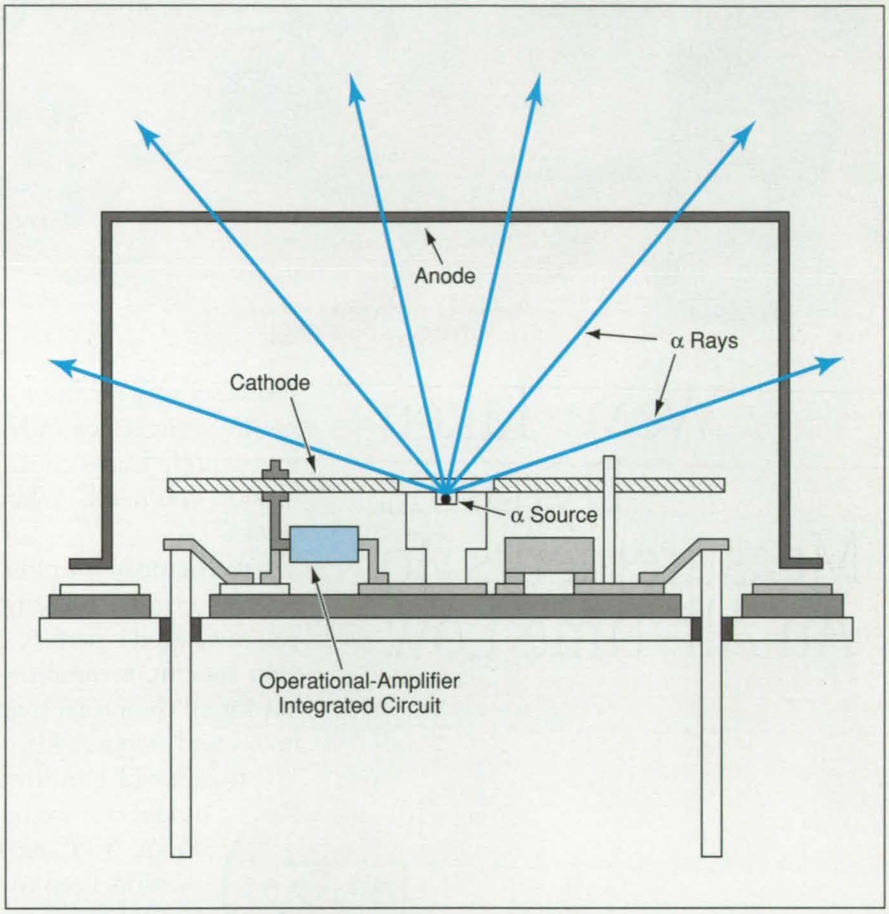
This device would fit into a cube of about 1 cm.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed gas-pressure gauge of the "alphatron" type would feature unusually wide dynamic range, small size, and low power consumption. Conceived for measuring the pressure of the Martian atmosphere, this gauge could also be used on Earth to measure atmospheric and subatmospheric gas pressures in scientific and industrial apparatus.

Alpha particle vacuum gauges have been out of common use for decades due to lack of a practical technology compatible with workplace safety standards. An alpha particle gauge is an ionization-type pressure gauge (more precisely, a density gauge) in which alpha particles (energetic helium nuclei) from a radioactive source produce positive ions in a gas. An electric field is imposed on the gas by applying a suitable electric potential to a cathode and anode, causing the positive ions to drift to the cathode and electrons to drift to the anode. The ionization current thus collected by the cathode is measured and taken as an indication of the density of the gas (equivalently, the pressure of the gas at a given temperature).

In the proposed miniature alpha gauge (see figure) the alpha particle source would be a small piece of an americium isotope, similar to those used in household smoke detectors. The source would be covered by a gold surface layer to attenuate the alpha particles to an optimum kinetic energy of the order of 1 MeV. The α source would be electrically grounded and located near the center of an annular-disk-shaped cathode. The cathode would be connected to the input pin of an operational-amplifier integrated circuit, making it possible to measure ion current as small as a fraction of a picoampere.



This **Miniature Alphatron** would respond linearly to pressures from 1 to 1,000 millibars.

A cylindrical-cup-shaped anode would be placed over the α source and cathode, and would be held at a positive potential. The dimensions of the anode must be chosen, in conjunction with other design parameters, so that at the maximum intended operating gas pressure, the range of the a particles is greater than the distance to the anode. This is important because, if the α tracks terminate within the active volume, then the number of ions produced is independent of pressure, and the sensor would no longer function as a pressure gauge.

Preliminary experiments and design calculations suggest that the ion current would be directly proportional to pressure over the range from 1 to 1,000 millibars (10^2 to 10^5 Pa) at standard temperature. Like other alphatrons, this one would offer the advantages of ruggedness and no moving parts. By use of surface-mount hybrid technology, it should be possible to fit this alphatron within a package of about 1 cm in each linear dimension.

This work was done by Martin G. Buehler, L. Douglas Bell, and Michael H. Hecht of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 153*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Larry Gilbert, Director
Technology Transfer
California Institute of Technology
Mail Code 315 - 6
Pasadena, CA 91125
(818) 395-3288

Refer to NPO-19622, volume and number of this NASA Tech Briefs *issue, and the page number.*

Micromechanical Oscillating Mass Balance

Advantages would include compactness and relative simplicity.

Lyndon B. Johnson Space Center, Houston, Texas

A micromechanical oscillating mass balance has been proposed for measuring small amounts (with resolution of the order of 10^{-8} g) of contaminant material deposited on its surface. As in the case of the commercial quartz-crystal microbalances now used as contamination detectors, the contaminant mass would be measured in terms of a small change in the frequency of resonance of mechanical oscillations.

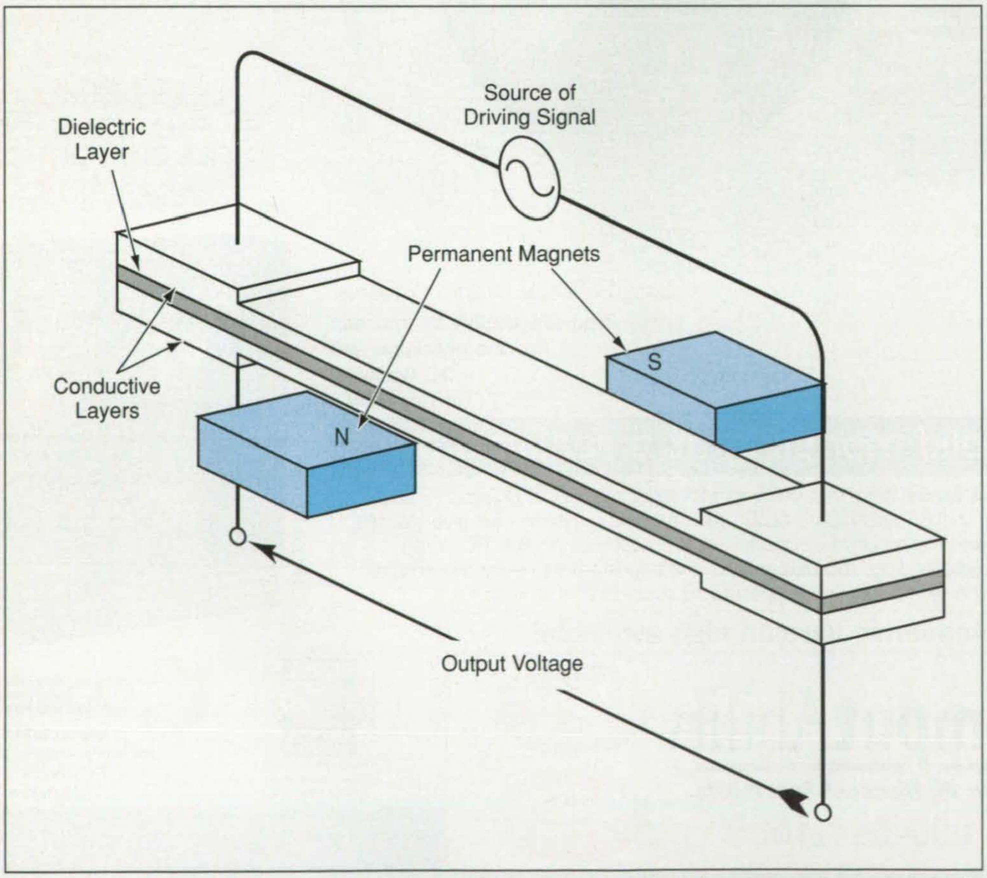
The micromechanical oscillating mass balance would include a conductor/dielectric/conductor laminated composite beam with both ends rigidly fixed (see figure). Typically, the beam would be about 3 mm long, 0.1 mm wide, and 6 μm thick, though of course the dimensions in a specific design could differ considerably from these representative values. The beam would be fabricated by techniques now used in the microelectronics industry and thus could be integrated on a silicon chip along with supporting electronic circuitry. The resonant frequency — that is, the frequency of the fundamental mode of vibration of the beam — would typically be a few kilohertz.

Permanent magnets would be mounted nearby to impose a magnetic field across the beam. An alternating current would be driven along one of the conductive layers on the beam, so that the force produced by the interaction between the current and the permanent magnetic field would set the beam into oscillation at the driving frequency. The oscillating motion of the other conductive layer in the magnetic field would generate alternating voltage between the ends of the beam in that layer; the amplitude of this output voltage could be measured as an indication of the amplitude of vibration.

During a measurement session, the output voltage would be measured as a function of the driving frequency; the resonant frequency would be identified as that driving frequency at which the output voltage reached its peak value. An accumulation of contaminant mass during the time between two measurement sessions would manifest itself as a decrease in the resonant frequency. Theoretical calculations show that a contaminant mass of only 10^{-8} g would decrease the resonant frequency by about 1 Hz in the typical case. Frequency shifts of these magnitudes are easily measurable by currently available equipment.

The smallness of the micromechanical oscillating mass balance would afford several distinct advantages over quartz-crystal microbalances and other related devices. The most obvious advantage is enhanced portability. The small size and mass of this device would also contribute to its ability to survive large vibrations and accelerations. Another important advantage pertains to thermal stabilization; smallness of size would minimize the effects of gradients of temperature, while smallness of mass would maximize the effectiveness with which the temperature of the device could be controlled. Temperature control could be accomplished easily by mounting this device directly on a Peltier device.

Another advantage would lie in relatively low cost associated with the relatively low driving frequency. Quartz-crystal microbalances operate at frequencies in the megahertz range, thereby requiring circuitry more expensive than that needed for operation in the kilohertz range. Yet another advantage would lie in the use of the fundamental mode of vibration of the beam. A theoretical analysis of the performance of a beam vibrating in its fundamental mode is easier than is the corresponding analysis for the quartz-crystal microbalance, which vibrates in a complex transverse mode.



The Beam Would Be Made To Oscillate by driving an alternating current along the upper conductive layer in the presence of the permanent magnetic field. The oscillation would be measured by measuring the voltage induced in the lower conductive layer.

This work was done by David Altemir of **Johnson Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 165*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center; (713) 483-4871. Refer to MSC-22569.

Improved Fillets To Withstand Thermal Shocks

Some material would be removed to reduce thermal gradients.

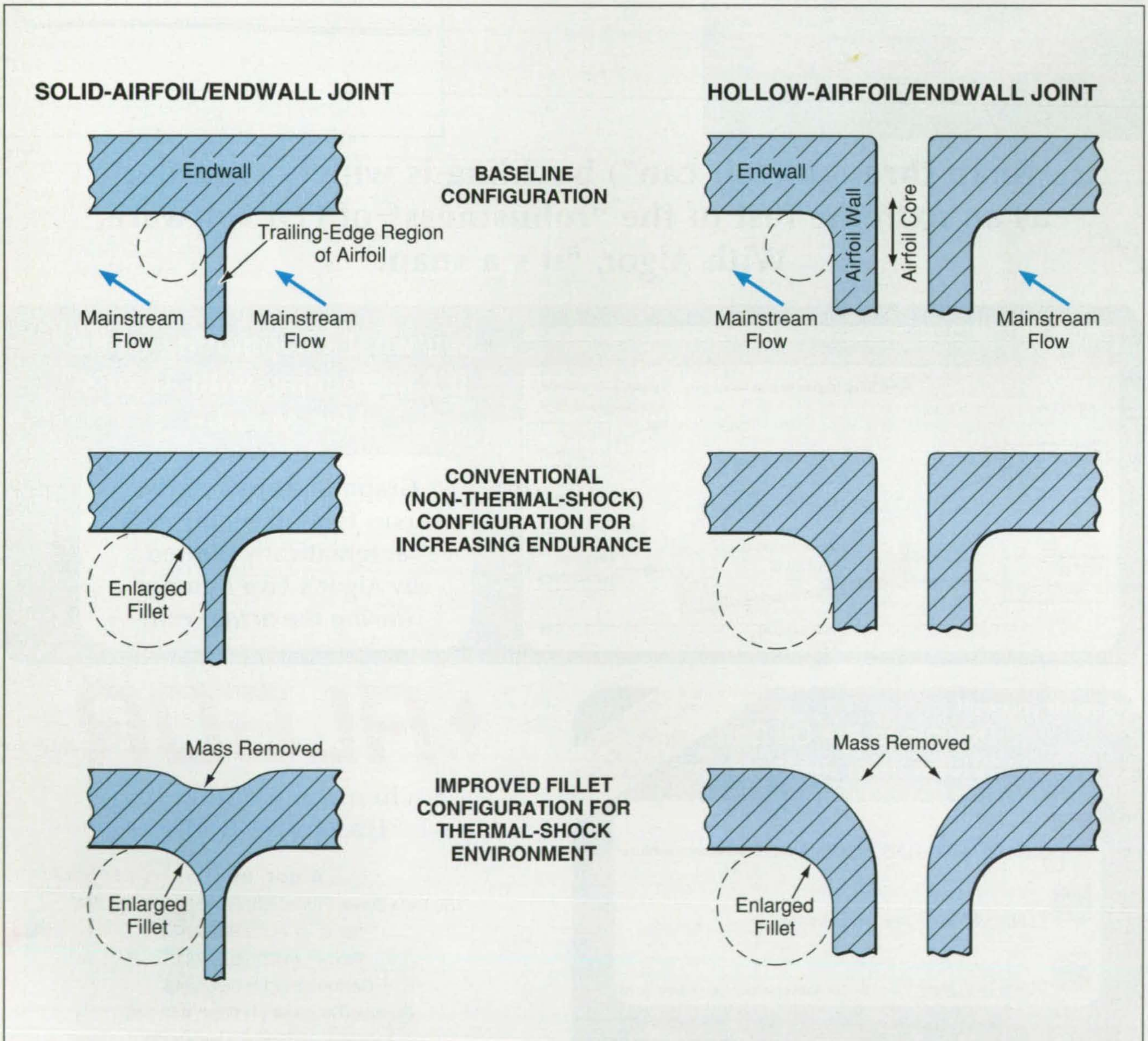
Marshall Space Flight Center, Alabama

Improved larger-radius fillets have been proposed to help some right-angle structural joints in turbine engines endure thermal shocks that occur during rapid heating and cooling. The joints in question could be, for example, those between turbine-vane airfoils and the endwalls that support the airfoils.

The problem of thermal shock (transient thermally induced mechanical stress) in joints of this type arises for the following reasons: It is well documented that in the absence of thermal transients, such a joint can be made more durable by increasing its fillet radius to reduce concentration of mechanical stresses. Unfortunately, in the presence of thermal transients, the mass added by increasing the fillet radius serves as a medium that supports increased local gradients of temperature; this causes thermal stresses to increase, negating the benefit of the larger fillet radius.

The figure shows representative solid- and hollow-airfoil/endwall joints in the baseline, conventional larger-fillet-radius (non-thermal-shock), and proposed larger-fillet-radius configurations. In the proposed configurations, the fillets would be enlarged to reduce concentration of stresses as in conventional practice. In addition, some mass would be removed from the back sides opposite the fillets. The removal of mass from the vicinity of the fillets would reduce thermal stresses by reducing the gradients between the typically higher temperatures along the sides of the airfoils and the typically lower mass-average temperatures of the fillet regions.

This work was done by Donald E. Paulus of United Technologies Pratt & Whitney for **Marshall Space Flight Center.** *No further documentation is available.*
MFS-28943



Removal of Mass from back sides opposite fillets would increase thermal-shock endurance by decreasing thermal gradients.

Thermostatic Valve for Low-Pressure-Drop Flows of Gas

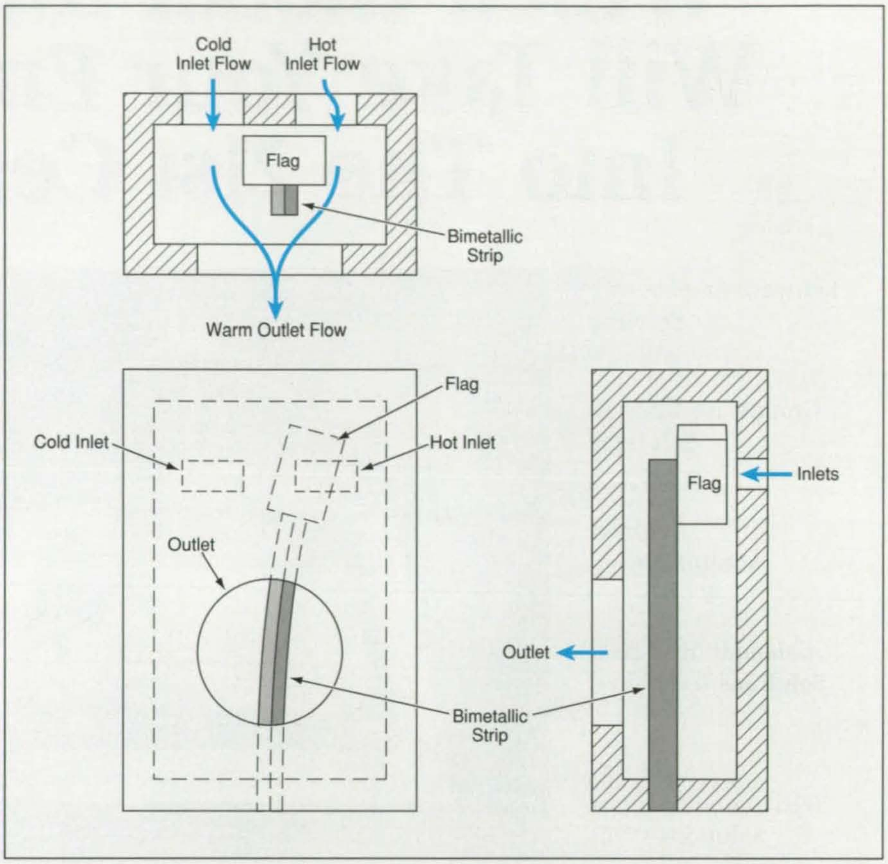
Hot and cold inlet flows are mixed to obtain intermediate temperature at the outlet.

John F. Kennedy Space Center, Florida

A thermostatic bypass diverter valve mixes hot and cold inlet flows of a gas to obtain an outlet flow at an approximately constant intermediate temperature. The valve (see figure) includes slotlike inlets and a flag mounted on a bimetallic strip. The flag can block either or both inlet(s) to various degrees, thereby altering the proportions of entering hot and cold flows. The degrees of blockage of the inlets depend on the bend of the bimetallic strip; this bend, in turn, depends on temperature.

The valve is intended for use in a system in which the pressure drops elsewhere along the relevant flow paths are low. It is anticipated that neither 100-percent cold flow nor 100-percent hot flow would ever be needed in this system. Therefore, leakage of either the hot or the cold flow through a nominally totally blocked inlet is not of concern, and the valve can be designed with generous clearances while still restricting the inlet flows enough to obtain the desired control. Large clearances can be utilized to reduce friction and drag, which could cause binding.

At the time of reporting the information for this article, the valve had not yet been tested for sensitivity to vibration. Should the valve prove sensitive to vibration in its operational environment, the mass of the flag and/or the bimetallic strip can be adjusted to avoid resonance, and/or the parts adjacent to the clearance gaps could be coated with polytetrafluoroethylene or a similar material to provide limited frictional damping.



This **Valve Mixes** hot and cold inlet flows of gas. The temperature-sensitive bend of the bimetallic strip determines the mixing proportions and thus the temperature of the outlet flow.

This work was done by Paul F. Berg of United Technologies Corp. for **Kennedy Space Center.** *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center; (407) 867-2544.
Refer to KSC-11871.

Optically Controlled Microvalves for Microfluidic Devices

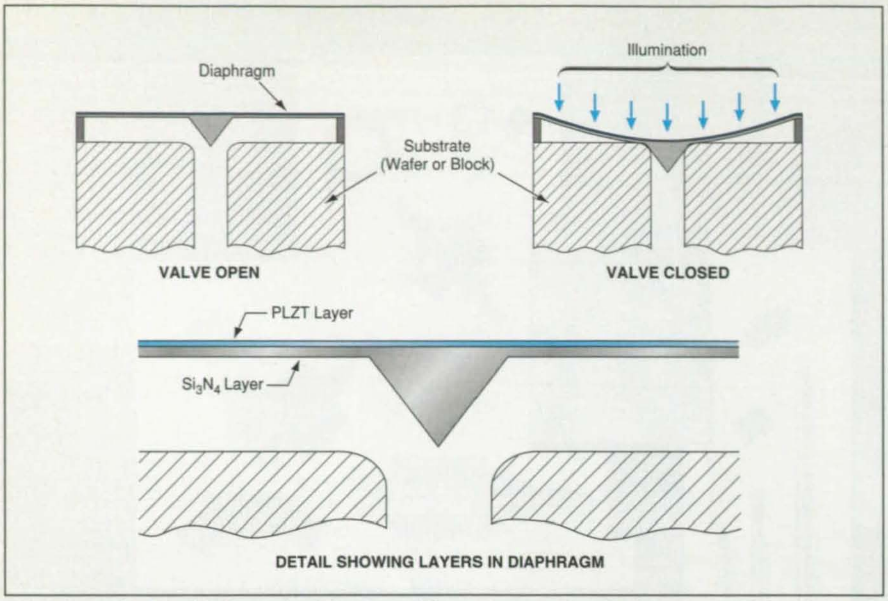
These valves would be actuated remotely, without external electrical connections.

NASA's Jet Propulsion Laboratory, Pasadena, California

Optically controlled microvalves have been proposed for use in microfluidic devices. These microvalves would be actuated remotely via the photoactuation effect that occurs in the ferroelectric/piezoelectric material lead lanthanum zirconate titanate (PLZT).

Microvalves are needed in biomedical, microchemical, microirrigation, microspacecraft, and microavionics applications. With miniaturization, it becomes desirable to eliminate the extra baggage of peripheral electronic controls and umbilical cords that are customarily used in remotely controlling valves equipped with electrically driven actuators. The elimination of electrical connections is especially important where there is a need for electrical isolation for safety; for example, in biomedical applications that involve the delivery of insulin or the control of flows in artificial organs. Photoactuation is thus an attractive option for such applications.

The basic principle of photoactuation by use of PLZT was described in "Thin-Film, Light-Energized Bimorph Micromechanical Actuators" (NPO-19607), *NASA Tech Briefs,* Vol. 20, No. 8 (August 1996), page 11a. The actuator in a microvalve of the proposed type would be made largely of PLZT, which could be either free-standing or formed on a thin substrate of Si, Si_3N_4, or other suitable material. The figure shows a proposed microvalve actuated by a two-layer (PLZT/Si_3N_4) diaphragm. Incident light would cause the diaphragm to bend down in the middle, closing the valve; a similar microvalve could also be configured so that illumination would



This **Microvalve Would Close** when illuminated from the top. The diaphragm would function as a photoactuator by virtue of the ferroelectric/piezoelectric effect in PLZT.

cause the valve to open. Such valves could be actuated by pulses of light to obtain pulses of flow and/or pressure in the fluids to be controlled.

The proposed microvalves would be made by micromachining techniques like those used to make very-large-scale integrated (VLSI) circuits, and could be embedded in VLSI wafers. They could be readily tailored to suit for specific applications. They could be produced in batches and could be inexpensive enough to be regarded as expendable.

This work was done by Sarita Thakoor and Terry Cole of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category,* ***or circle no. 147*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
NPO-19661

Removable, Reusable Handle

The handle can be attached and detached quickly and easily.

Lyndon B. Johnson Space Center, Houston, Texas

A detachable handle fits specially designed modular equipment cabinets. There is no need to provide each cabinet with its own handle; weight is thus saved and a streamlined cabinet surface is preserved. The handle can be installed and removed with only one hand. It can be used quickly, its state is unambiguous, and its operation is reliable.

The handle mates with a baseplate that is bolted to a face of a cabinet. A human or robotic operator first inserts a stub that protrudes from the handle into a positioning receptacle on the baseplate, then turns the handle 90° clockwise, so that interlocking conical surfaces of the stub and receptacle slide into contact. The operator pushes a locking button within the reach of a thumb on the handgrip rail on the handle. This action causes a pin to protrude from the stub into a hole in the receptacle in the baseplate, thereby locking the handle to the baseplate and cabinet.

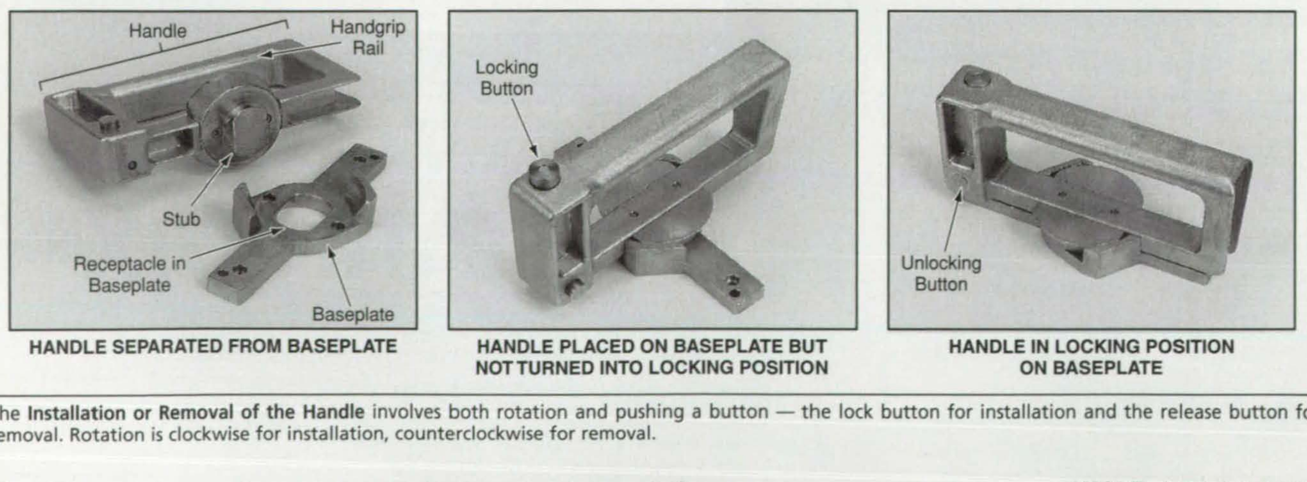
To remove the handle, the operator pushes a releasing button near the baseplate. The releasing button is placed far enough from the locking button that the releasing button is unlikely to be pushed accidentally. The operator rotates the handle 90° counterclockwise and can then extract the handle from the baseplate. Even if the release button were pushed inadvertently, the handle would still have to be rotated 90° to be released fully. Inasmuch as only one of the two buttons can protrude at any time, the user can easily see the state of locking.

This work was done by Robert P. Nespodzany, Jr., of Honeywell, Inc., for **Johnson Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category,* ***or circle no. 163*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act {42 U.S.C. 2457(f)}, to Honeywell, Inc. Inquiries concerning licenses for its commercial development should be addressed to:

Mr. Ron Champion
Honeywell, Inc.
Satellite System Operations
PO Box 52199
Phoenix, AZ 85072-2199
(602) 436-1980

Refer to MSC-22126, volume and number of this NASA Tech Briefs issue, *and the page number.*



The **Installation or Removal of the Handle** involves both rotation and pushing a button — the lock button for installation and the release button for removal. Rotation is clockwise for installation, counterclockwise for removal.

Mechanical Components

Comair Rotron, San Ysidro, CA, offers the Diplomat® DC 7.5" **motorized impeller**, which operates at 330 CFM and uses brushless DC motor technology. It is available with the ThermaPro-V™ forced convection cooling technology that allows the user to program it to adjust speed with temperature, set the speed desired, or maintain a constant speed when voltage varies.

The impeller operates at 12, 24, and 48 VDC and can be used for pressurization or evacuation of enclosures in computers, peripherals, and filtering. Options include an inlet ring, fan performance sensors, ball bearing construction, tachometer output for failure sensing, and harness assemblies.

For More Information Circle No. 723

The SSW201 Series **non-contact speed switch** from OMEGA Engineering, Stamford, CT, combines the function of a proximity switch with a timing network for motion control of rotating machinery. The switch features adjustable high- or low-speed setpoints and incorporates a power-up time delay that allows the detected object to accelerate to normal operating speed when the switch is used as a low alarm.

The switch is in a non-conductive state below, and conducts above the predetermined setpoint. It is available in low and high frequency ranges, and is suitable for use in dirty, humid, oily, and dusty applications.

For More Information Circle No. 724

Penn Engineering & Manufacturing Corp., Danboro, PA, offers Type PF11™ **panel fasteners**, which enable quick assembly and panel removal, and eliminate the need for loose hardware. The PEM® self-clinching panel fastener assemblies feature a large knurled knob with a combination slot/ Phillips drive for finger or tool operation.

The shoulder feature provides a positive stop when the fastener installs in the sheet. The assemblies are available in thread sizes #4-40 through #8-32 and M3 and M4. They are available with a black finish.

For More Information Circle No. 725

Thomson Saginaw, Saginaw, MI, offers **metric ball screw assemblies** that meet ISO Class-5 precision of 25 μm/300mm (0.001 in/ft). The assemblies are available in 96 styles and configurations, in preloaded and non-preloaded versions ranging from 12 x 5 to 50 x 50 (diameter mm x lead mm). End-flanged, center-flanged, and cylindrical nut configurations are offered.

Suited for replacing acme-screw and hydraulic and pneumatic actuators, the ball screws feature low power consumption, quiet operation, and positioning accuracy and repeatability.

For More Information Circle No. 728

The HN series RF **connectors** from Tru-Connector Corp., Peabody, MA, are made of brass with a silver or nickel finish, and silver- or gold-plated brass, phosphor-bronze, or beryllium-copper center conductors. They feature Teflon® dielectric interfaces and long dielectric creep paths, and incorporate 3/4"-20 couplings. The connectors handle up to 5,000 volts, provide 50 ohms impedance, and operate over a 0 to 4 Ghz frequency range. Designed to fit cables from 0.195" to 0.945" OD, they are available as straight-through and right-angle plugs, jacks, plug receptacles, and as in-series and between-series adapters.

For More Information Circle No. 729

Southco, Concordville, PA, has introduced the Rotary Action **draw latch**, which operates like a standard draw latch, drawing two panels together with over-center clamping force. The latch is available in two styles: a concealed spring-loaded version and a fixed anchor plate version. The concealed spring-loaded version compensates for mounting-hole irregularities, panel variations, and gasket set, and absorbs shock and vibration to reduce rattling.

A lift and twist action opens the latches, preventing a latch from snapping open. Both versions are available in a stainless steel finish for indoor/outdoor applications, and a steel finish with black powder coating, which offers 400 hours of UV protection.

For More Information Circle No. 731

Monkey on your back #31: How to find a UNIX® workstation that loves running Windows NT®

Until now, purchasing a workstation required you to choose between UNIX® and Windows NT.® Thanks to the new DIGITAL Personal Workstation au-Series, that's no longer the case. It's the only RISC workstation that truly runs both UNIX and Windows NT. Which means if you're currently using UNIX, you can easily migrate to Windows NT, whether you want to do it a year from now or this afternoon. And not only does the DIGITAL Personal Workstation dramatically reduce your purchase, support and migration costs, but at speeds up to 600MHz, it's the fastest workstation you can buy. What's more, the DIGITAL Personal Workstation runs all major UNIX and Windows NT applications today. So the choice is clear: if you want a workstation that gives you the best of both worlds, the new DIGITAL Personal Workstation is the one you're sure to love. **For more information, or to learn more about our free 2.1 GB disk offer, call 1-800-DIGITAL and ask for a workstation specialist or visit www.workstation.digital.com.**

DIGITAL Personal Workstation for Windows NT and UNIX

Choice of 433MHz, 500MHz and 600MHz Alpha 21164 processors

ECC SDRAM memory 0-2MB L3 cache

5 PCI slots (2 PCI, 3 PCI/ISA)

DIGITAL PowerStorm® 3D Graphics, AccelPro Series, Matrox Millennium Graphics

d i g i t a l™
Whatever it takes.℠

288

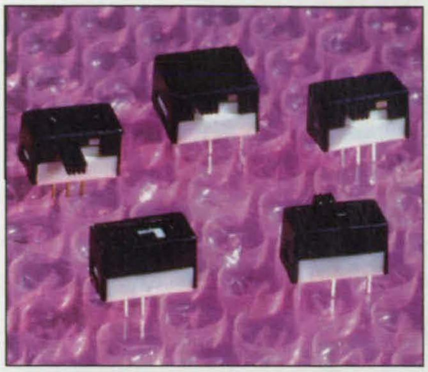
For More Information Circle No. 533

Mechanical Components

EPI Teflon® **seals and bearings** from Engineering Plastics, Westboro, MA, can be cold-molded and machined with user-specific compositions. The seats, seals, and bearings are made from virgin PTFE and PTFM Teflon with pigments for color-coding. They can be produced in sizes from 3/8" to 60" in diameter, in shapes including V-ring, U-ring, split-, cup-, and lip-seals.

The components are chemically inert and moisture resistant. They can be mineral-filled for steam resistance, glass-filled in varying percentages for long wear and stiffness, and bronze-filled for self-lubricating bearing applications requiring strength and lubricity. The components are produced in prototype to production quantities.

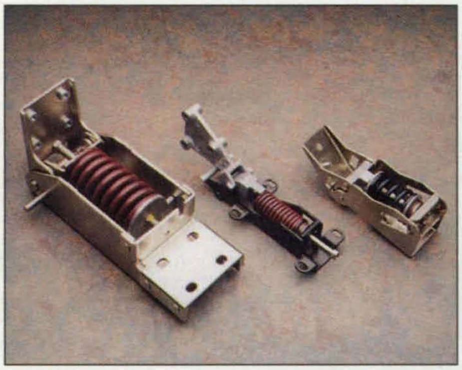
For More Information Circle No. 721



E-Switch, Brooklyn Park, MN, offers the 600 Series **slide switches** available in gold or silver contacts with a choice of PC board footprints to accommodate many design layouts. Silver contacts are rated at 4A at 120V; gold contacts provide a rating of 0.4VA maximum at 20V maximum.

Multiple actuator options, including right angle, recessed, and extended actuator versions, can be specified in SPDT or DPDT configurations. Applications include electronics, automotive, appliances, medical equipment, test and measurement equipment, and telecommunications.

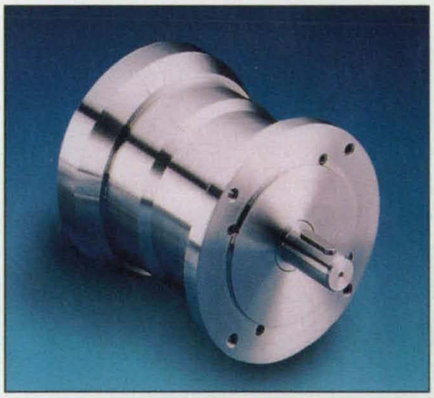
For More Information Circle No. 720



Weber Knapp, Jamestown, NY, has introduced a line of **spring-counterbalanced hinges** for controlled lifting, holding, and closing forces. They hold loads in an infinite number of positions, and prevent unassisted closing of lids, doors, hoods, hatches, and movable and articulating arms.

The hinges are temperature-resistant and combine the functions of a hinge with position control capabilities. They are compact and can be used as an alternative to position control devices such as cranks, gas cylinders, torsion bars, and electric motors.

For More Information Circle No. 722



Bayside Controls, Port Washington, NY, offers **stainless steel gearheads** with ServoMount™ design that allows mounting to any motor. The pinion is pre-mounted in the gearhead housing with a floating bearing that automatically compensates for motor shaft runout or misalignment.

Features include corrosion-resistant stainless steel housing, FDA-approved FM grease and stainless steel gearing, round housing design, and a housing sealed to IP65 Standard for protection against internal contamination.

For More Information Circle No. 726

ControlAir, Amherst, NH, has introduced the Ultra line of **linear air cylinders** for applications requiring precise force response to small pressure variations. The cylinders combine a rolling diaphragm seal, a hardened steel shaft, and Thomson Class A linear ball bearings. They are available in stroke ranges from 0.7 to 6.0" and operate at plant air supply pressures to 145 psi. Custom diaphragm materials allow operation at temperatures from -75°F to +400°F.

Applications include thread tensioning/positioning, controlled clamping force, polishing and grinding machinery, and precision actuation. Universal, foot, and clevis bracket mounting options are available, as well as a variety of diaphragm materials, springs, and bearings.

For More Information Circle No. 730

The WhisperDrive **gearhead** from Cone Drive Textron, Traverse City, MI, is wear-compensating, enabling zero backlash to be maintained without the need for adjustment for the life of the servo system. It is lightweight, compact, and provides repeatable positioning.

Features include elimination of worm endplay, 300% momentary overload capacity, versatile mounting, solid or hollow output shaft, and inch or metric dimensioned shafting. The gearhead is sealed for life and is factory-filled with synthetic lubricant.

For More Information Circle No. 727

Electronic Components and Circuits

Active-Pixel Image Sensor with Regional Electronic Shutter

Integration time in each region is adjusted to prevent saturation or loss of signal.

NASA's Jet Propulsion Laboratory, Pasadena, California

Scientific NASA applications — the star tracker, for instance — require imagers with wide dynamic ranges. When a single integration period for an entire image sensor is used (as in a CCD system) to capture bright stars with dim stars, either the bright star is properly exposed but the dim stars are lost in the noise, or the dim stars are properly exposed but the bright star is saturated. Ratios between brightnesses of objects captured in the same scene (e.g., a planet and nearby stars) might be as large as 10^8. To enable simultaneous observation of bright stars without saturation and dim stars without loss of signal, a sensor with regional-electronic-shutter capability is necessary. Such a sensor is described here.

In the star-tracker application, a spacecraft-guidance system determines spacecraft attitude by matching an observed star field to a star catalog. Typically, a few stars with different magnitudes are used for tracking in a given field of view. Using the regional electronic shutter, each star in the field of view can have its own integration period. This way, simultaneous capture of bright stars with dim stars is accommodated, enabling a large increase in tracker capability.

The regional electronic shutter provides a suitable integration time for each of several regions in different parts of the array. This is done by implementing individual pixel reset, which was previously reported in "Image Sensors With Individual Pixel Reset" (NPO-19735), *NASA Tech Briefs*, Vol. 20, No. 11, (November 1996), page 34, within each pixel thus controlling the integration time for a specific region. Individual pixel reset makes it possible to shorten integration time, such that if the illumination is high, the pixel still will not be saturated. This is done by controlling the reset gate via two lines that carry the column and row reset control voltages. When both the row- and column-address voltages are set high for the specific address, the pixel at that address can be reset. Using information from previous frames, the appropriate integration time for the region could be determined, and control is provided to implement this exposure time via a regional electronic shutter.

The concept has been implemented in a 64-by-64-pixel CMOS active pixel image sensor chip that achieves a dynamic range of 80 dB, a read noise of 50 electrons (root mean square), low dark current, and excellent electronic-shutter linearity. This prototype paves the way for lower-risk development of similar 1,024-by-1,024-pixel sensors with regional electronic-shutter capability.

This work was done by Orly Yadid-Pecht, Bedabrata Pain, Christopher Clark, Craig Staller, and Eric Fossum of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Circuits category,* ***or circle no. 117*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Larry Gilbert, Director
Technology Transfer
California Institute of Technology
Mail Code 315 - 6
Pasadena, CA 91125
(818) 395-3288

Refer to NPO-19816, volume and number of this NASA Tech Briefs *issue, and the page number.*

Wide-Band Operational-Amplifier Circuits

Frequency responses are extended by incorporation of suitably chosen input capacitances.

Goddard Space Flight Center, Greenbelt, Maryland

The top part of the figure illustrates typical operational-amplifier circuits with resistive feedback networks, while the bottom part of the figure illustrates circuits that are identical except for the connection of capacitors between the inverting (–) and noninverting (+) input terminals. The frequency response of each circuit can be extended by suitable choice of the capacitance, as explained below.

For each operational amplifier considered in isolation from other circuit components (the open-loop case), the magnitude of the gain (K) as a function of frequency (f) is given by

$$|K_f| = |K_0|/[1 + (f/f_3)^2]^{1/2},$$

where K_0 is the dc gain, and f_3 is a characteristic frequency popularly denoted the "3-dB rolloff frequency" because the power at that frequency is half (approximately 3 dB below) the power at zero frequency. When the operational amplifier is incorporated into a feedback circuit (the closed-loop case), the gain is altered by the presence of the other circuit components.

In the case of the inverting operational-amplifier circuit, the magnitude of the closed-loop gain is given by

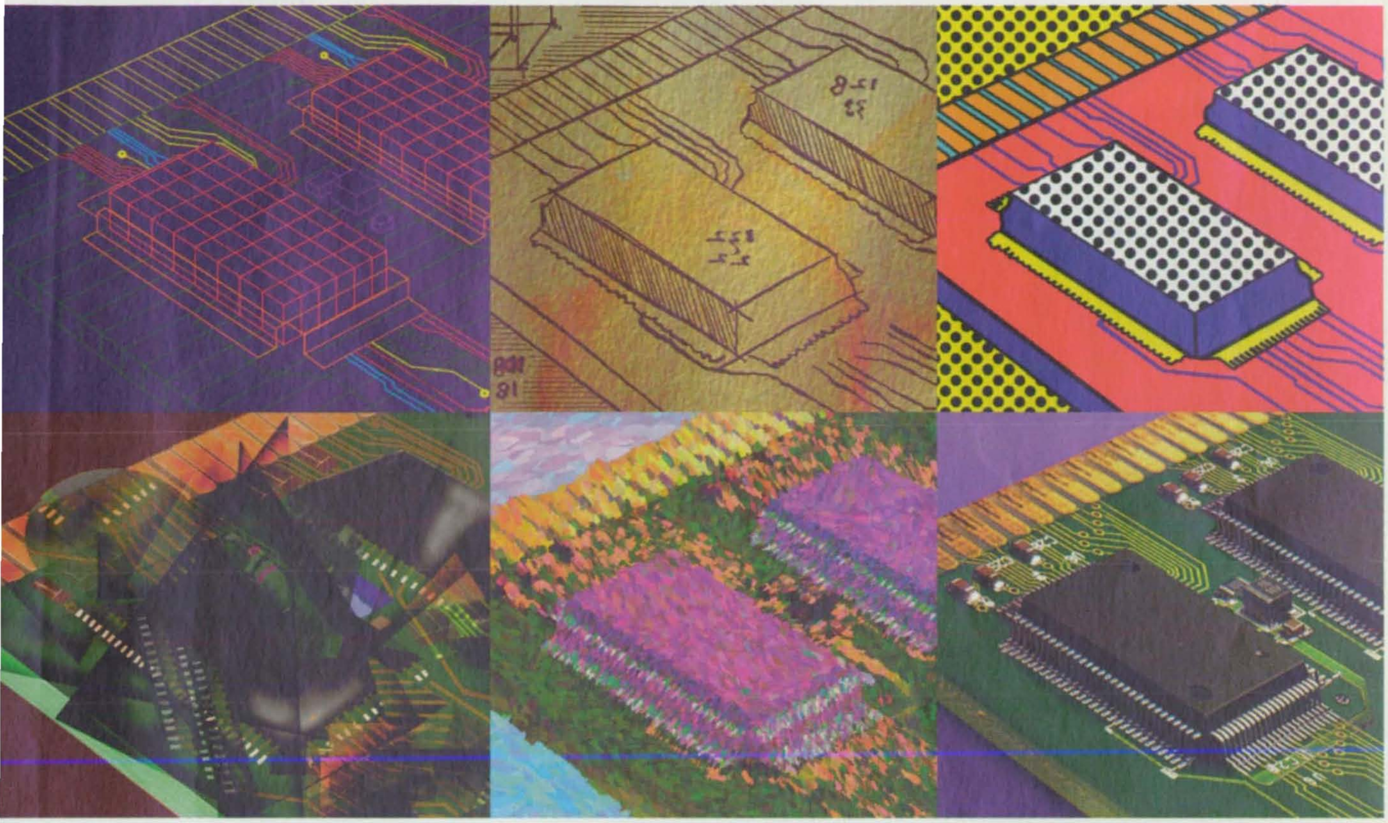
$$|K_{FB}| = |V_{OUT}(f)/V_{IN}(f)| = (f_G/f)/\{(1+\alpha)^2 + [(f_G\alpha/f) - (f/f_G\alpha\beta)]^2\}^{1/2},$$

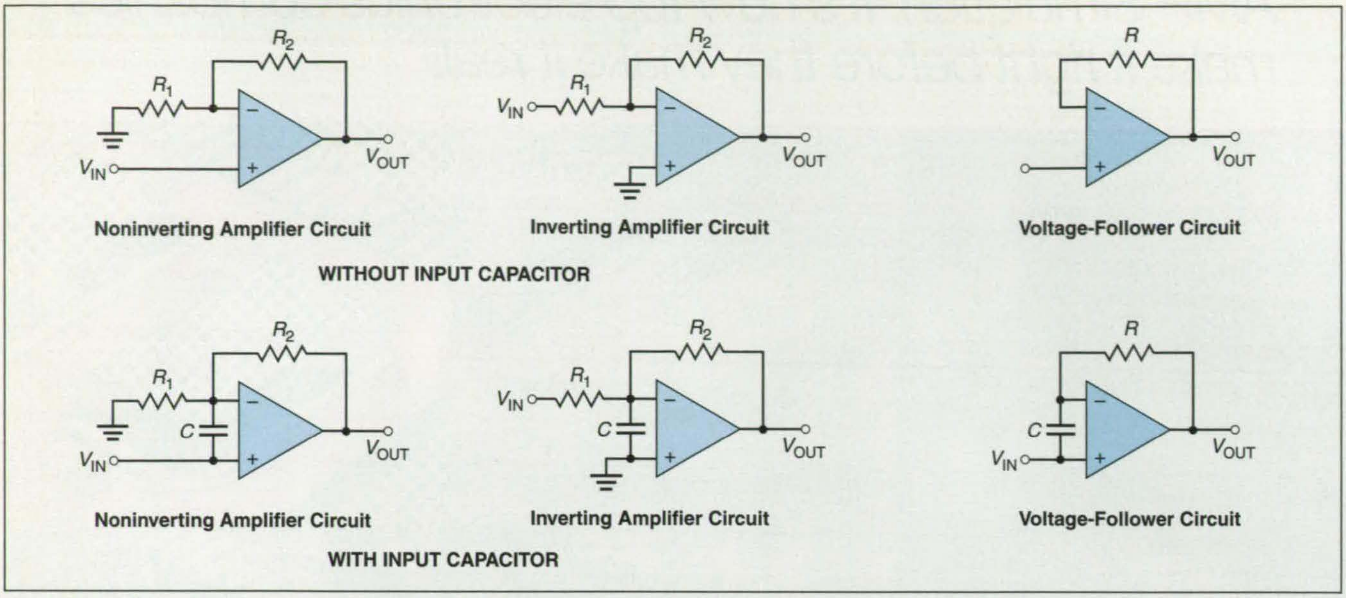
where f_G denotes the open-loop gain·bandwidth product K_0f_3,

$$\beta = (R_1 + R_2)/(2\pi R_1R_2C\alpha f_G),$$

and α in this case equals R_1/R_2. For the noninverting operational-amplifier circuit, the corresponding equations are

$$|K_{FB}| = (f_G/f)/\{1 + [(f_G\alpha/f) - (f/f_G\alpha\beta)]^2\}^{1/2},$$





The **Addition of Input Capacitors** can extend the frequency responses of these circuits, provided that the values of capacitance are suitably chosen.

where α in this case equals

$$R_1/(R_1 + R_2).$$

For the voltage follower, the magnitude of the closed-loop gain is given by

$$|K_{FB}| = (f_G/f)/\{1 + [(f_G/f) - (f/f_G\beta)]^2\}^{1/2}$$

(for the voltage follower, $\alpha = 1$).

The following procedure can be used to select a suitable value of C for extending the frequency response of any of these circuits beyond that attainable without the capacitor:

1. Choose two different frequencies at which it is desired to have $|K_{FB}|$ equal a specified value. Let the specified value exceed the corresponding values of $|K_{FB}|$ at the chosen frequencies for the circuit without the input capacitor.
2. Using the chosen frequencies and the specified value of $|K_{FB}|$, find the value of β that satisfies the applicable one of the three equations for $|K_{FB}|$.
3. Once the value of β has been found, calculate C by use of

$$C = (R_1 + R_2)/(2\pi R_1 R_2 \alpha\, \beta\, f_G)$$

for the inverting or noninverting amplifier, or by use of $C = 1/2\pi R\beta f_G$ for the voltage follower.

This work was done by Leonard Kleinberg of **Goddard Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Circuits category,* ***or circle no. 118*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center; (301) 286-7351. Refer to GSC-13638.

Transverse-Mode Electron-Beam Microwave Generator

This device offers advantages over klystrons.

Goddard Space Flight Center, Greenbelt, Maryland

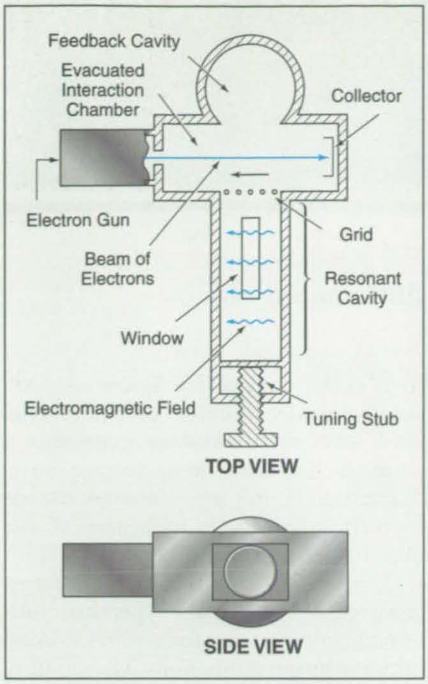
A vacuum-tube electron-beam device generates microwave energy via the interaction between an electron beam and an electromagnetic field in an evacuated cavity that has electrically conductive walls. In some respects, this device is similar to other vacuum-tube electron-beam microwave devices — especially klystrons — but it differs from klystrons in ways that offer significant advantages.

A klystron is said to operate in a longitudinal mode because its operation entails bunching of electrons along the beam, accompanied by interaction between the bunches of electrons and an electromagnetic field with an electric-field component parallel to the motion of electrons in the beam. To generate microwave power that can be extracted and used, it is necessary to amplify the electromagnetic field.

In a klystron, amplification depends on maintenance of the correct phase relationship between the motions of the bunched electrons and the electromagnetic field in the cavity. Thus, the operation of a klystron is sensitive to the times of flight of electrons and, therefore, to the voltages applied to accelerate the electron beam. The anti-bunching effect of the mutual repulsion of the electrons limits the achievable density of electrons and thus the available output power. Inasmuch as power losses caused by imperfections in cavity surfaces increase with frequency, the anti-bunching effect thus effectively limits the operating frequency; in practice, klystrons cannot generate useful amounts of power at frequencies above approximately 100 GHz.

In the present device (see figure), an electron gun shoots a beam of electrons into an evacuated interaction chamber that has electrically conductive walls. After the electrons have traversed the interaction chamber and spent their energy interacting with the electromagnetic field in the chamber, they are collected by an electrode at a positive voltage at the end of the chamber opposite the electron gun.

At an opening in one of its side walls, the interaction chamber is joined to a



This **Vacuum-Tube Electron-Beam Device** is superior to a klystron in that its operation does not depend on maintenance of critical voltages, and it can generate a useful amount of power at higher frequency.

rectangular resonant cavity that has conductive walls and a screw-adjustable conductive tuning stub. At an opening in the opposite side wall, the interaction chamber is connected to a conductive-walled spherical feedback cavity. The dimensions of the resonant cavity and the sphere are low-order multiples of the wavelength of operation. The frequency of operation is relatively insensitive to applied voltages: it is determined primarily by the dimensions of the resonant cavity and can be adjusted by moving the tuning stub.

A grid of wires spaced about half a wavelength apart is placed in the opening between the resonant cavity and the interaction chamber. The geometry of the feedback and resonant cavities, the grid, and the interaction chamber determines which electromagnetic-field modes can be sustained. Unlike a klystron, this device can be said to operate in transverse mode in the following sense: Electromagnetic waves propagate across the interaction chamber from the resonant cavity to the spherical feedback cavity, where they are transformed into waves that have radial electric-field components. These waves are reflected back into the interaction chamber, where they deflect the beam of electrons from side to side in an oscillating motion at the frequency of the electromagnetic field. The spatial variations of the electromagnetic field are such that as the beam oscillates sideways, it gives up energy to the field. Thus, the field becomes amplified. Electromagnetic energy is extracted for use through a window on one side of the resonant cavity.

Unlike a klystron, the present device does not depend on bunching. Consequently, its operating frequency is not limited by the anti-bunching effect. As a further consequence, it is not necessary to maintain a critical phase relationship between bunches of electrons and the electromagnetic field. Thus, the accelerating voltage in the electron gun can be varied without adversely affecting the operation of the device; indeed, this voltage can be varied deliberately to modulate the microwave field.

This work was done by Lawrence Wharton of **Goddard Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Circuits category,* ***or circle no. 110*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center; (301) 286-7351. Refer to GSC-13521.

Fast Three-Dimensional-Imaging Camera

The output level of each pixel represents the direction toward an illuminated object.

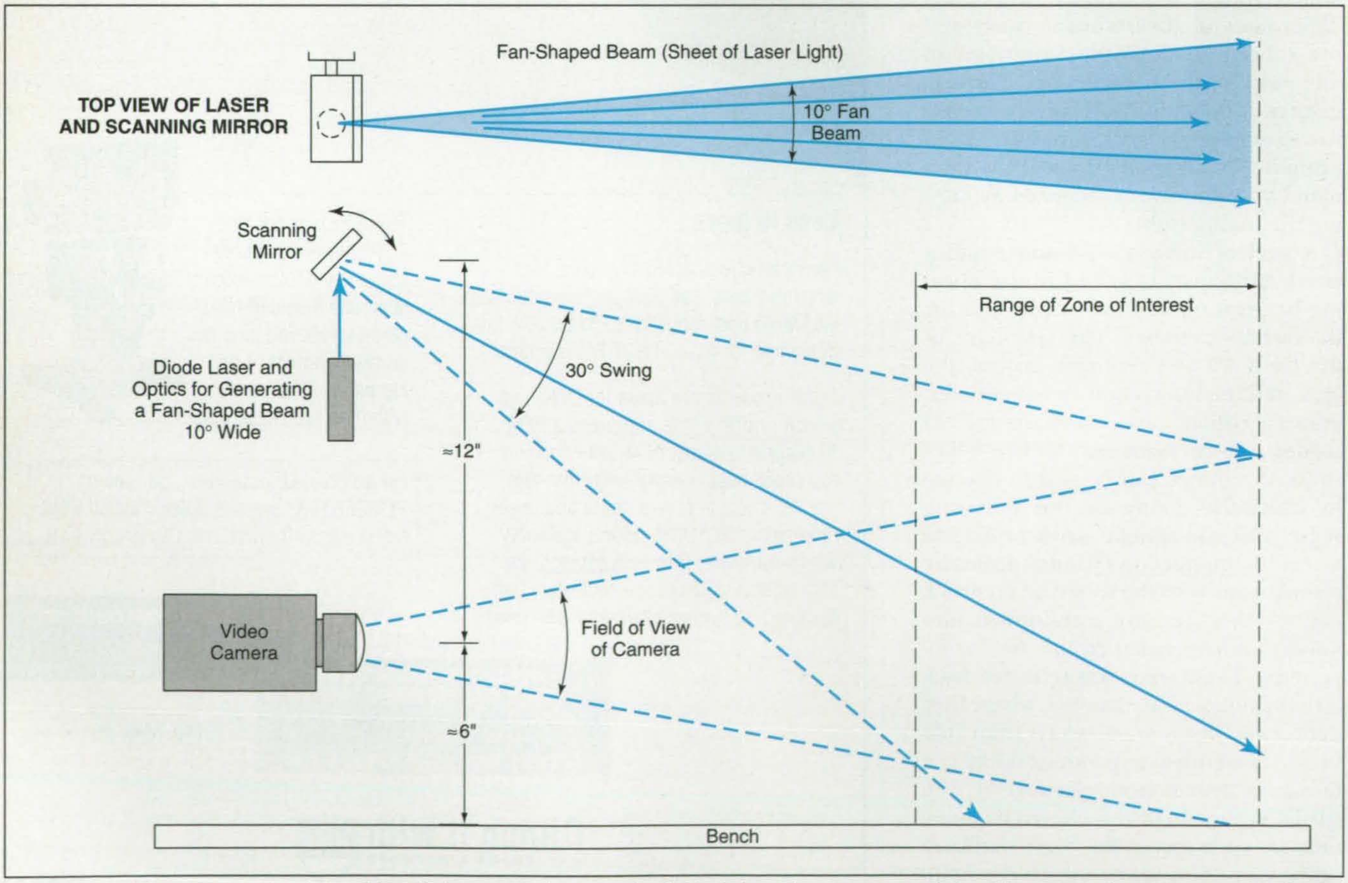
Marshall Space Flight Center, Alabama

The Fast 3D Imaging (F3DI) camera is a developmental system that measures the three-dimensional coordinates of objects within its field of view at distances up to a few feet. The F3DI camera comprises analog and digital electronic, electromechanical, and optical subsystems that function together to generate a range image and/or the digital-data equivalent of a range image. (A range image resembles a conventional video image except that the brightness of each pixel represents the distance to the nearest object point along the line of sight intercepted by that pixel.) A prototype of the system operates at a selectable frame rate up to about 30 Hz.

This system is based on triangulation, using (1) a laser and optics that form the laser beam into a fanlike sheet that projects a line of light onto the nearby scene and (2) a video camera with a field of view that intersects the sheet of light. The distance to an illuminated point of an object imaged onto a given pixel is readily computed from (1) the known baseline distance between the video camera and the laser illuminator, (2) the known direction of the line of sight between the pixel and the illuminated point, and (3) the known orientation of the sheet of light with respect to the baseline and the line of sight.

As described thus far, this system is similar to some other video ranging systems based on triangulation. However, this system implements the triangulation principle in unique ways. The laser illuminator includes a scanning mirror that, during each frame period, sweeps the fan-shaped laser beam through a 30° angular interval that crosses the field of view of the camera (see figure). A shaft-angle encoder monitors the scan angle, and associated circuitry generates a scan-synchronized ramp voltage waveform; that is, the instantaneous voltage of this waveform is indicative of the instantaneous scan angle.

The video camera is of the charge-coupled-device (CCD) type, but with modifications to perform some nontraditional imaging functions. The circuitry in each pixel in the camera includes electronic switches and a capacitor that, together, act as a sample-and-hold device. At the beginning of each frame period, a synchronizing pulse from the scanning-control circuitry causes one electronic switch to discharge the capacitor, then the capacitor-discharging electronic switch is opened and a capacitor-charging switch is closed.



The **Scanning Mirror Sweeps** the sheet of laser light repeatedly across the field of view. The raw output of the video camera is not a conventional video signal, but rather, one in which the voltage for each pixel is indicative of the scan angle at which the object point imaged on the pixel was illuminated.

CONFIDENT SOLUTIONS

DuPont Vertrel® has more answers for your precision cleaning needs.

The DuPont Vertrel® family of solvents offers the versatility and performance you've been looking for. A broad range of Vertrel® cleaning and defluxing alternatives provide you with the solution that best fits your application.

More than just cleaning

Vertrel® is the best and only solution for all your needs. It uses advanced HFC (hydrofluorocarbon) technology to bring solutions to rinsing and drying applications. It's also an outstanding carrier fluid for fluorolubricants and silicone.

All formulations are environmentally acceptable as alternatives to ozone-depleting substances. And low toxicity and nonflammability make Vertrel® safe to use.

To learn more about confident solutions from DuPont Vertrel®, call **1-800-441-9281**.

DUPONT

Vertrel®

Only by DuPont

For More Information Circle No. 552

Then as the scan progresses, the capacitor is charged with the ramp voltage. The photodetector in each pixel is used, not to measure the local image brightness, but, rather, as a threshold triggering device; when the fan laser beam crosses the point in the scene corresponding to the pixel, light reflected from that point is focused onto the pixel by the camera lens, and the amplified output of the photodetector in the pixel causes the capacitor-charging electronic switch to open. Thus, the charge on the capacitor is frozen at a voltage representative of the scan angle. This charge constitutes the CCD pixel readout signal for the frame period. The readout signals from all the pixels are digitized and used, along with pixel locations, to address an electronic lookup table that contains precomputed relationships among ramp voltages, scan angles, lines of sight, pixel positions, and ranges. The lookup process can be accomplished in a fraction of a microsecond on a typical computer. The results of the lookup can be processed into a range image or presented as digital range data.

This work was done by Leonard S. Haynes of Intelligent Automation, Inc., and Rudy Dyck for **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Systems category,* ***or circle no. 102*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
MFS-26484

Computerized Generation of Inspection Reports

John F. Kennedy Space Center, Florida

Pen-based computers running special-purpose software serve as input devices in a computerized inspection-data-recording system. The system was developed to speed inspections, promote consistency of inspection data, facilitate verification of the data, and provide for the printing of inspection reports in a standard format. Previously, inspectors had followed an error-prone, time-consuming procedure in which they recorded their observations in handwritten notes and sketches on paper. Designed specifically for inspections of the thermal protection system on space shuttles, the inspection system could likely be adapted, with modifications, to enhance productivity in other situations in which many inspection reports must be processed. The software provides pop-up menus for primary input. These menus help to reduce errors by restricting an inspector to displayed standard choices. Elements of artificial intelligence in the software automatically reconfigure the pop-up menus on the basis of selected input from an inspector (for example, to present choices that pertain only to the area currently under examination); this feature also helps to prevent errors. An on-screen pop-up keyboard is also available for entry of alphanumerical data. An inspector must still make sketches, but now does so directly on the computer screen for immediate digital recording; thus, images can later be retrieved and printed out quickly and easily.

This work was done by Stephen M. Schneider and Daniel B. Mondshein of United Space Alliance for **Kennedy Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Systems category,* ***or circle no. 114*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center; (407) 867-2544. Refer to KSC-11898.

Improved System for Tracking Inventory of Hazardous Wastes

John F. Kennedy Space Center, Florida

An improved computerized system for tracking an inventory of hazardous wastes has been developed to replace an older tracking system in which manually generated reports were entered manually into computers. The older system required labor-intensive, time-consuming procedures and was prone to errors and delays; the improved system overcomes these disadvantages and affords

Kid's stuff.

Our stuff.

The DIGITAL Personal Wo
meet your performance r
support your most deman
For Windows NT users, ch
processors, or our a-Serie
processors. For your most
au-Series, featuring DIGIT

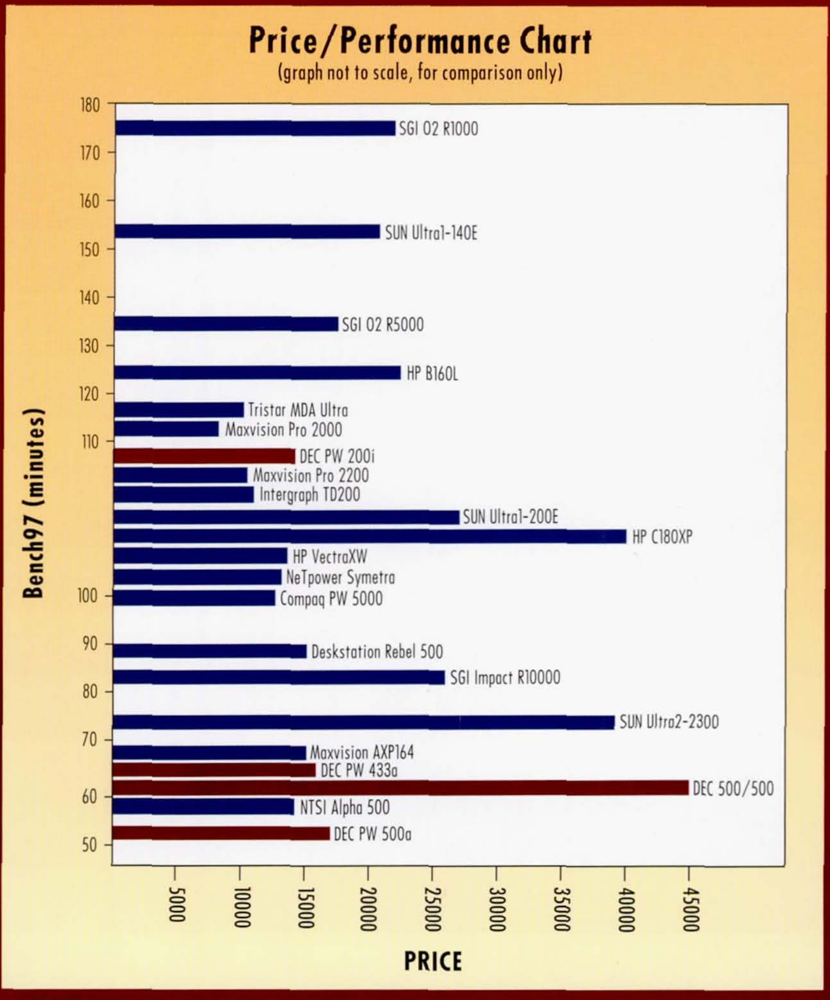
digital™

"Nobody can offer an NT workstation that can do the things that DIGITAL can do."

The Wall Street Journal
"DIGITAL to Unveil Alpha Workstations" (January 27, 1997)

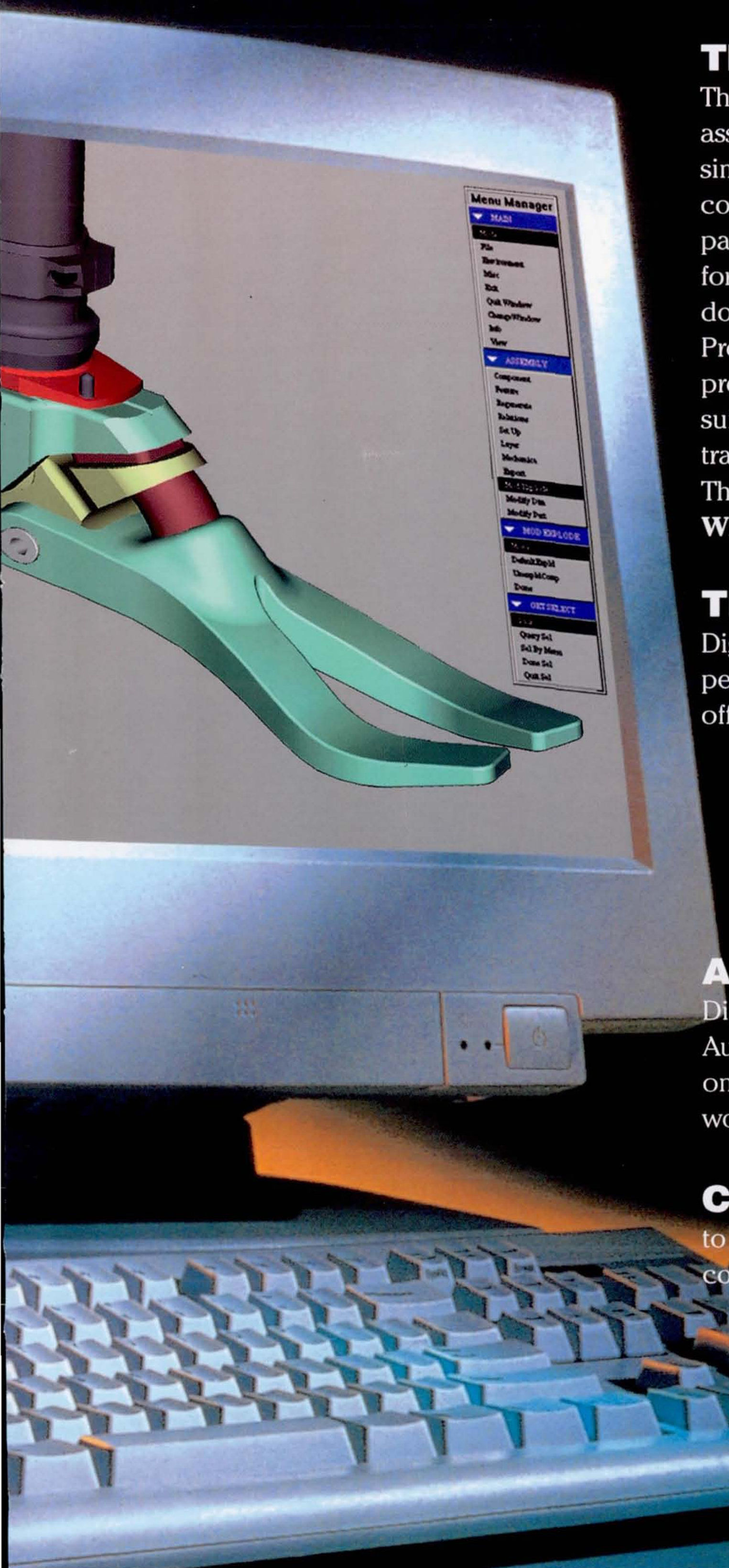
"They [DIGITAL] are going to be the ones to beat in this space,"

Computerworld
"New Alpha Workstations" (6 January, 1997)



Call 1-800-

family offers you a range of choices to
ay – with a highly scalable design to
plication requirements as they evolve.
i-Series, featuring Intel® Pentium® Pro
the super-powerful DIGITAL Alpha
ing UNIX applications, choose our
processors running DIGITAL UNIX.



Which would you rather design with?

The Software.

The PT/Products™ family includes a fully associative suite of mechanical design functional simulation and manufacturing applications. The core module, PT/Modeler™, is a robust, 3D, parametric, feature-based, solid modeling system for part and assembly design, detailing, and documentation. Based on the proven technology of Pro/ENGINEER®, the PT/Products family is production-ready and dependable software ideally suited for manufacturing companies making the transition from 2D CAD systems to solid modeling. The U.S. list price for PT/Modeler is only $2995. **Why pay more for less?**

The Hardware.

Digital, the world's leading supplier of high performance Windows NT personal workstations, offers a family of Intel and Alpha platforms

- which make all other solutions look like child's play.
- which will run PT/Products at blazing speeds without busting your drawing allowance.

A Powerful Team.

Digital, in combination with PT/Products Authorized Resellers, is offering special incentives on both Intel and Alpha-based Windows personal workstations for maximum performance.

Call 1-800-DIGITAL for full details. Ask to speak to a workstation specialist and refer to code "QKP". You'll find more information at:

http://www.ptproducts.com
http://www.workstation.digital.com

TAL for more information about our stuff.

Want to know more?

Fax your request today to (617) 246-4218
or e-mail us at ptc@stassoc.com

☐ **Please send me more information on PT/Products and Digital Workstations.**

☐ **Please send me a free CDROM demo on PT/Products and Digital Workstations.**

Name

Title

Company

MS/Dept.

Address

City State Zip

( ) AM/PM
Phone (Circle one)

( )
Fax

E-Mail

Fax this card or call 1-800-DIGITAL for more information about Digital workstations and Parametric software. Ask to speak to a workstation specialist. Refer to code "QKP".

digital

PARAMETRIC TECHNOLOGY CORPORATION

Want to know more?

Fax your request today to (617) 246-4218
or e-mail us at ptc@stassoc.com

☐ **Please send me more information on PT/Products and Digital Workstations.**

☐ **Please send me a free CDROM demo on PT/Products and Digital Workstations.**

Name

Title

Company

MS/Dept.

Address

City State Zip

( ) AM/PM
Phone (Circle one)

( )
Fax

E-Mail

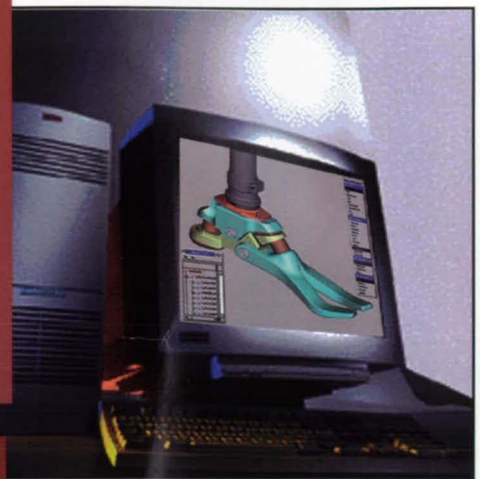
Fax this card or call 1-800-DIGITAL for more information about Digital workstations and Parametric software. Ask to speak to a workstation specialist. Refer to code "QKP".

digital

PARAMETRIC
TECHNOLOGY
CORPORATION

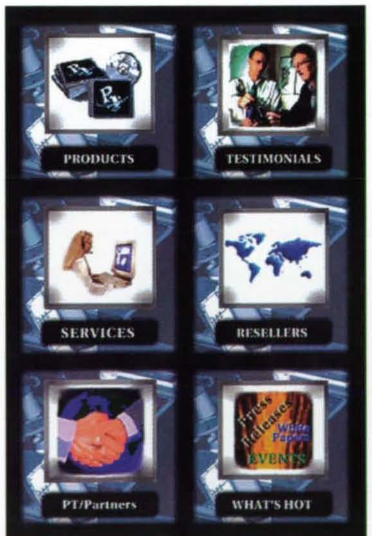
Explore our web sites and discover technology.

digital



http://www.workstation.digital.com

PARAMETRIC
TECHNOLOGY
CORPORATION



http://www.ptproducts.com

the additional advantages of standardization and centralization. As in the system described in the preceding article, the points of contact with human technicians are pen-based computers that run special-purpose software that provides pop-up menus, bar codes, buttons, and other interactive displays for entry of data in standard formats. These computers are carried in the field and used to record such data as locations, amounts, and types of wastes. These computers also provide on-line access, in the field, to more than 250 packages of information on the proper technical responses to hazardous-waste situations.

This work was done by Thomas D. Adamson and Stephen M. Schneider of Lockheed Martin Space Operations for **Kennedy Space Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Systems category,* ***or circle no. 108*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center; (407) 867-2544. Refer to KSC-11900.

Improved Ultraviolet-and-Infrared Hydrogen-Flame Detector

Small hydrogen flames can be distinguished from other sources of light.

John F. Kennedy Space Center, Florida

An optoelectronic instrument for detecting small hydrogen flames includes analog and digital circuitry (see figure) that processes the outputs of two infrared photodetectors and an ultraviolet photodetector to determine whether a small hydrogen fire lies within its field of view. As in the case of commercial ultraviolet-and-infrared hydrogen-fire detectors, the design of this instrument reduces the incidence of false alarms by taking advantage of the fact that hydrogen fires emit flickering light in both ultraviolet and infrared spectral bands, whereas other sources that one does not seek to detect emit only steady light (e.g., hot objects and reflections of sunlight) or else flicker in the ultraviolet only (e.g. welding arcs and lightning).

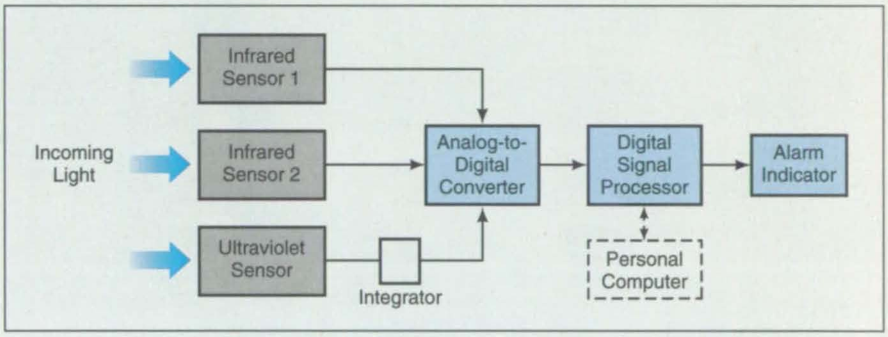
This instrument offers an advantage over the commercial units in that its overall design, including its digital-signal-processing algorithm has been formulated, on the basis of experimental observations, to provide reliable detection of a small hydrogen flame within its field of view while reducing the probability of a false alarm from hydrocarbon flames and from moving people and animals. The design also suppresses false alarms that would otherwise be caused by light from a large nearby hydrogen flame that one does not seek to detect because it has been lit deliberately: it does this by distinguishing between the faster fluctuation of light from the small hydrogen flame and the slower fluctuation of light from the larger flame.

In the experiments that guided the formulation of the design, it was observed that when the radiation incident on the infrared and ultraviolet detectors originated from the same hydrogen flame and came directly from that flame (rather than by way of reflection), the time-domain cross-correlation of the output waveforms of the infrared and ultraviolet detectors indicated a high degree of similarity between the waveforms. When the detectors were also receiving light from other sources, the cross-correlation indicated that the waveforms differed. In addition, frequency analysis of the infrared waveforms showed that in the particular application, the flicker of the large flame was concentrated at frequencies < 5 Hz, while the flicker of the small flame extended to tens of hertz.

In the operation of the instrument, the output of the ultraviolet detector, which is originally a series of pulses, is integrated to convert it into a continuous signal. The integrated output of the ultraviolet photodetector and the outputs of the two infrared photodetectors are sent to an analog-to-digital converter. The digitized signals are sent to a digital signal processor that computes the frequency spectrum of the flickering of the ultraviolet and infrared signals. The digital signal processor also computes the cross-correlation of the ultraviolet and the infrared signals.

If the analysis of the flicker indicates that light from the large flame is being received either directly or by reflection, the signals are high-pass filtered to so that only frequency components of flicker above 5 Hz are used to compute the cross-correlation. If the cross-correlation is larger than a preset threshold between 0.5 and 0.6 (a correlation value of 1.0 indicates identical waveforms) and if the analysis of the flicker indicates that the source of the radiation is a small flame rather than the large one, an alarm is generated.

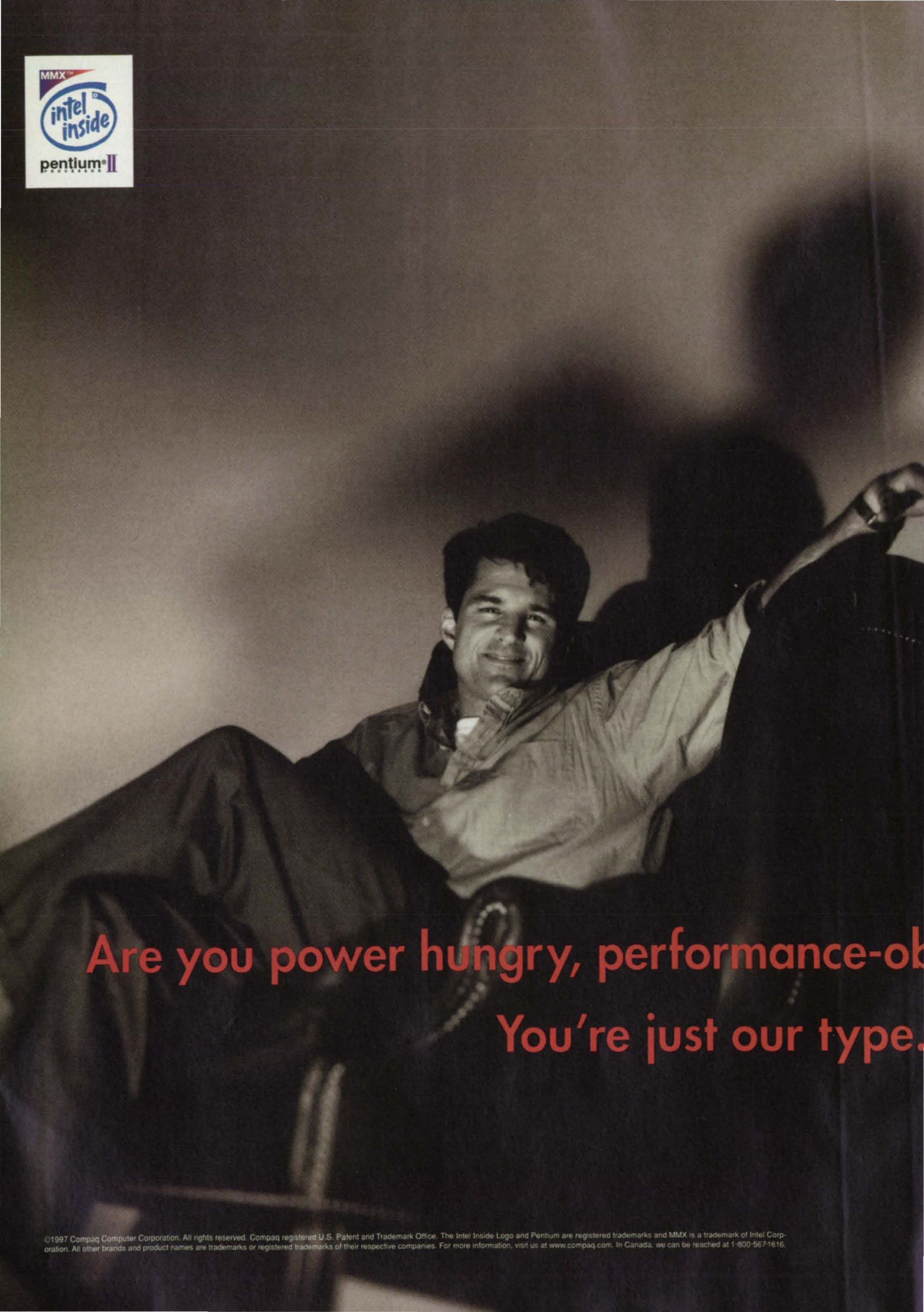
The alarm condition is updated repeatedly every 2 seconds: The cross-correlation at any given time is computed on the ultraviolet and infrared signals received during the preceding two seconds. When the cross-correlation value falls below a threshold level between 0.3 and 0.4 after having previously triggered an alarm, the alarm is terminated.



The **Improved Hydrogen-Fire Detector** includes circuits that process the outputs of ultraviolet- and infrared-photodetector outputs to extract cross-correlations and frequency characteristics indicative of small hydrogen fires. The connection to the personal computer is made, when needed, to change alarm-condition correlation thresholds.

This work was done by Gregory A. Hall of **Kennedy Space Center** *and Pedro J. Medelius and Howard James Simpson of I-NET. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Systems category,* ***or circle no. 107*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

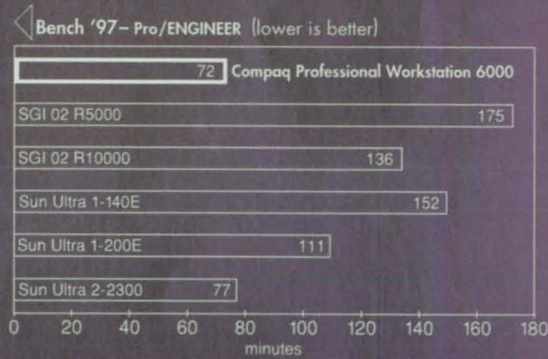
This invention has been patented by NASA (U.S. Patent No. 5,625,342). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Kennedy Space Center; (407) 867-2544. Refer to KSC-11775.



MMX™
intel inside
pentium® II PROCESSOR
Are you power hungry, performance-ob
You're just our type.
©1997 Compaq Computer Corporation. All rights reserved. Compaq registered U.S. Patent and Trademark Office. The Intel Inside Logo and Pentium are registered trademarks and MMX is a trademark of Intel Corporation. All other brands and product names are trademarks or registered trademarks of their respective companies. For more information, visit us at www.compaq.com. In Canada, we can be reached at 1-800-567-1616.

…essed, and ego-driven?

Introducing the new expanded family of Compaq Professional Workstations. The 5000, 6000, and 8000 Series are powerful NT systems that not only outperform other industry standard workstations, but most UNIX systems as well. Interested in faster time to market? Our innovative highly parallel system architecture gives you advanced multiprocessing so you can utilize up to two Pentium® II processors or four Pentium Pro processors. The dual PCI buses give you parallel access to peripheral devices and our dual memory controllers provide you with bandwidth that's two to four times faster (1.06GB/s) than competitive Intel-based workstations. These Compaq NT-based workstations are optimized to run premier engineering applications like Pro/ENGINEER, I-DEAS Master Series, Unigraphics, AutoCad, SolidWorks 97 and MicroStation. And your choices don't stop there. We are forging new



partnerships with leading CAE application vendors like Altair Computing Inc., ANSYS Inc., Fluent Inc., The MacNeal Schwendler Corp., and Mechanical Dynamics Inc. It all comes down to this. You want power. You want performance. You want proof. We're going to give them to you. Call your local Compaq Authorized Reseller and ask about our "try and buy" program.

COMPAQ

Physical Sciences

Alternating-Precessive-Slab Laser Preamplifier

The size and the number of components would be minimized.

Goddard Space Flight Center, Greenbelt, Maryland

A laser preamplifier for a pulsed-laser ranging system amplifies pulses with a wavelength of 1,064 nm, duration of < 100 ps, and repetition rates of up to 5 kHz. The preamplifier features a compact design with a minimum number of optical components and simplicity of alignment. Using typical design parameters, the entire preamplifier could fit in a box about the size of a human hand.

The design concept is derived from common laser amplifiers that feature zigzag optical paths and external beam-steering optics to increase gain lengths. In this preamplifier, the amplified laser pulse is kept in the gain medium as long as possible, without need for external beam-steering optics. The gain of this preamplifier is comparable to that of a typical multipass zigzag amplifier with external beam-steering optics.

The design of this amplifier is called "alternating precessive slab" for reasons that will become apparent. The gain medium is a rectangular slab of 1-percent-doped neodymium: yttrium aluminum garnet (Nd:YAG) crystal, which lases at the desired wavelength of 1,064 nm and has an absorption spectral peak at 809 nm. Input and output faces are cut at two corners of the slab and coated for low reflectivity at 1,064 nm. The other faces are coated for high reflectivity at 1,064 nm and low reflectivity at 809 nm. The path traced by the laser pulse in traversing the slab (see Figure 1) includes internal reflections at a succession of points along each side, so that, in a sense, the path precesses around the slab. The design is characterized as "alternating" because the location of the output face alternates between opposite corners if the design parameters were changed in such a way as to make N (the number of x- or y-oriented segments of the path) alternate between even and odd values.

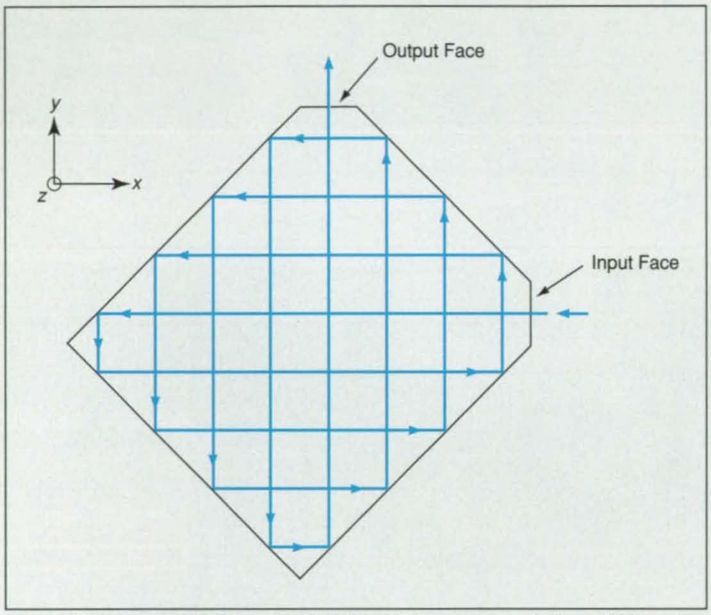


Figure 1. The **Optical Path Would Be Folded** into a pattern that would keep the laser pulse in the rectangular slab (the gain medium) as long as possible.

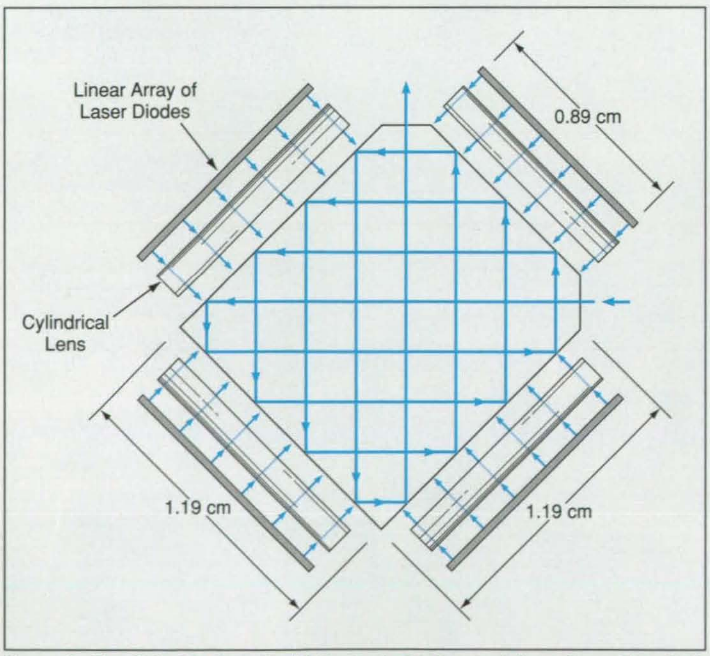


Figure 2. The **Gain Medium Could Be Optically Pumped** from four sides. Each array of laser diodes would typically operate at a power of 15 W each.

Typically, the overall dimensions of the slab are about 1 by 1 by 0.2 cm. The exact dimensions must be chosen to obtain the desired N and to satisfy other requirements. The slab must be thick enough to accommodate the cross section occupied by the laser pulse (in effect, the width of the laser beam). The choice of thickness is also affected by partially conflicting requirements related to coupling efficiency, diffraction, and quality of the output beam. The path in the slab must be laid out to prevent overlapping of the cross sections from adjacent path segments.

The slab could be optically pumped according to any of several alternative optical-pumping schemes. For example, as shown in Figure 2, pump light could be generated on four sides by linear arrays of continuous-wave (CW) laser diodes and collimated into the slab by cylindrical lenses.

This work was done by D. Barry Coyle of The American University for **Goddard Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 123*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
GSC-13326

Light-Scattering Measurements of Regression of Fuel Droplets

The measurement principle is that of diameter-dependent resonance scattering from spheres.

Marshall Space Flight Center, Alabama

A proposed optoelectronic instrument would exploit the diameter-dependent resonance scattering of laser light from transparent spheres to measure the regression of liquid fuel droplets in spray flames. As used here, "regression" denotes a decrease, caused by evaporation, in the diameter of a droplet. The proposed instrument could be integrated with (a) a laser Doppler velocimeter for measuring the velocities of droplets; (b) a phase Doppler interferometer for measuring the sizes of droplets; and (c) a rainbow refractometer for measuring temperatures of droplets and obtaining additional information about their sizes.

A description of rainbow phenomena is prerequisite to an explanation of the proposed instrument. The commonly recognized aspects of a rainbow can be understood in terms of a geometrical-optics-based theory proposed by Descartes several hundred years ago. The angular location of the primary rainbow arc for a given wavelength (called simply the "rainbow angle") can be understood to correspond to that scattering angle at which intensity of first-order internally reflected rays achieves a local maximum. To one side of the rainbow angle is a shadow region into which no rays emerge and to the other side is a lit region that contains additional rainbow arcs, called "supernumerary arcs," which are interference fringes that cannot be understood in terms of geometrical optics.

A point of light that is part of a supernumerary arc can be understood as arising from interference between two different rays of the same order emerging in the same direction. Thus, at any given scattering angle slightly greater than the rainbow angle, the scattered light includes rays that have followed two different paths through a droplet. To further complicate the situation, the interference of the internally reflected rays with externally reflected rays gives rise to high-frequency intensity oscillations that are superimposed upon the supernumerary arcs. These oscillations are extremely sensitive to small changes in the diameters of droplets. The proposed instrument is based on the proposition that these oscillations can be measured and, with suitable processing, data on changes in the diameters of regressing fuel droplets can be extracted from the measurements.

The extraction of droplet-regression data could proceed according to either or both of two approaches called the "phase" approach (for determining small changes in the sizes of drops) and "frequency" approach (for determining the rates of regression of drops). In the phase approach, the rainbow signature of a regressing droplet would be recorded at two known, closely separated instants of time. The recorded rainbow signatures would then be digitally processed to extract only the high-frequency contributions, and the two high-frequency signals would be correlated to extract the difference between their phases. This phase difference, ($\Delta\phi$) would be a measure of the change in the diameter of the droplet (ΔD) according to

$$\Delta\phi/\Delta D \approx d\phi/dD = (2\pi/\lambda)\{\cos\theta_0 - \cos\theta_2 + 2m\cos[\sin^{-1}(\sin\theta_2/m)]\},$$

where ϕ is the instantaneous phase of the high-frequency signal at the rainbow angle, D is the instantaneous diameter of the droplet, λ is the wavelength of the scattered light, θ_0 and θ_2 are the angles of incidence of light on the droplet that give rise, respectively, to the externally and internally reflected rays that emerge at the rainbow angle, and m is the index of refraction of the droplet at wavelength λ.

In the frequency approach, the intensity of scattered light would be monitored by a photodetector through a very small aperture located at the rainbow angle. As the droplet regressed, the intensity would oscillate at a frequency equal to the rate of regression multiplied by the expression on the right side of the equation above. The validity and feasibility of both the phase and frequency approaches have been demonstrated in experiments in which a "breadboard" prototype of the instrument was used to observe both nonburning and burning droplets made by a piezoelectric droplet generator.

This work was done by Subramanian V. Sankar, Dale H. Buermann, and William D. Bachalo of Aerometrics, Inc., for **Marshall Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 101*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center; (205) 544-0021. Refer to MFS-26402.


Data Acquisition
& PC Measurements
First with USB
SmartLink Measurements
Available exclusively from Channel K. The only USB* equipped measurement devices. Link a wide array of measurements from signal source directly to network or bus. From $574!
Write in No. 678
SmartDAQ PCI Boards
High performance from Channel K. 12- and 16-bit PCI data acquisition boards featuring on-board DSP. Up to 64 inputs. Up to 330 kS/s scanning. Multifunctional. From $1195!
Write in No. 679
TestPoint Software
Channel K has it now. The most intuitive Windows-based software package for data acquisition, analysis, and control. Easy to use. Minimal programming. License-free executables. Only $995!
Write in No. 680
oh no!
Don't let yesterday's equipment complicate your application today. Get the latest in universal serial bus (USB), PCI, and software products from Channel K. Just call 1-888-KEITHLEY for a free catalog of all our data acquisition products. Couldn't you use a little less stress?
oh yeah!
How to get it.
How to use it.
CHANNEL
K
KEITHLEY METRABYTE
Call 1-888-KEITHLEY to get a free catalog!
(534-8453)
*Universal serial bus; available with SmartLink Fall '97

Acoustic Wind-Velocity Analyzer

The measurements are inherently compensated for variations in atmospheric conditions.

NASA's Jet Propulsion Laboratory, Pasadena, California

An instrument performs acoustic measurements to determine the velocity of the wind in a plane. More specifically, the instrument measures the apparent speeds of propagation of sound through the wind along two known perpendicular directions in the plane. The speed and direction of the wind can then be determined from the known relationships between these speeds and the speed of sound in still air. Because the instrument also measures the speed of sound in a sample of air shielded from the wind, the measurements are inherently compensated for variations in temperature, pressure, humidity, and other atmospheric conditions.

The instrument, illustrated schematically in Figure 1, includes transmitting acoustic transducer A, plus receiving acoustic transducers B, C, and D. The line from A to C (along the y axis) is perpendicular to the line from A to B (along the x axis), and both these lines are exposed to the wind. The line from A to D is shielded from the wind.

The time for a sinusoidal signal to propagate from an acoustic emitter located at position A to reach the three microphones (acoustic receivers) located at B, C, and D is measured. The three propagation times are determined by comparing their received sine waves and their respective zero-crossing times (phase measurement) to the zero-crossing time of a reference sinusoidal signal. The distance from the center of the emitter to each of the microphones is known, and therefore, the velocity vectors v_{AB}, v_{AC}, and v_{AD} are determined. The speed of sound in still air, v_{AD}, is known because the path AD is shielded from the wind.

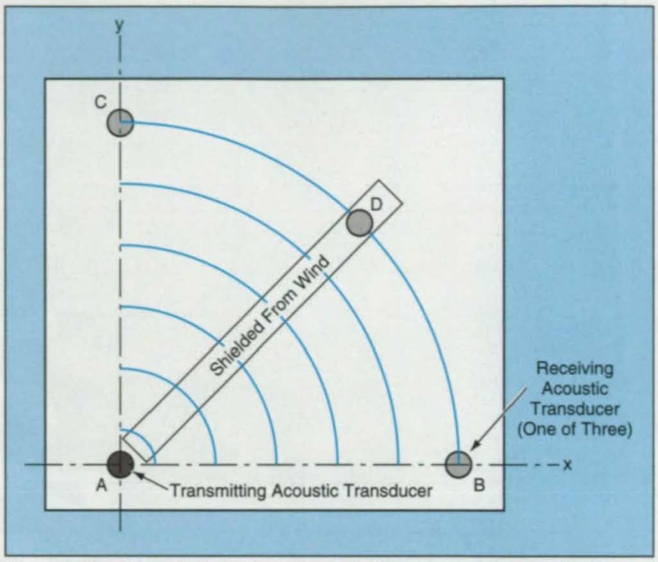


Figure 1. The **Acoustic Transducers** are used to measure the speeds of sound along the x and y paths exposed to the wind and along a third path shielded from the wind.

Figure 2 illustrates the computation of velocity. Let w = the speed of the wind. To first order in w/v_{AD}, the speed of sound along each of the two perpendicular paths through the wind equals the speed of sound in still air plus the component of wind velocity along that path. Thus, the two perpendicular components (w_x, w_y) of wind velocity can be obtained from $wx = v_{AB} - v_{AD}$ and $wy = v_{AC} - v_{AD}$. Then the speed of the wind is given by

$$w = (W_x^2 + W_y^2)$$
$$= \left[(v_{AB} - v_{AD})^2 + (v_{AC} - v_{AD})^2 \right]$$

and the angle, ϕ, of the wind relative to the x axis is given by

$$\phi = \tan^{-1}(w_y / w_x) = \tan^{-1}$$
$$= \left[(v_{AC} - v_{AD}) / (v_{AB} - v_{AD}) \right]$$

The instrument operates under control by a microprocessor, and a microprocessor performs the velocity computations. These and other features make the instrument competitive with conventional mechanical wind-measurement devices. Moreover, microprocessor circuitry provides an interface with external electronic data-processing equipment.

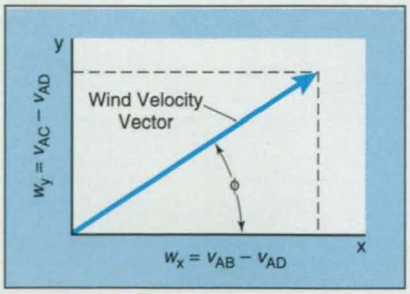


Figure 2. The **Velocity Computations** are based on simple linear superposition of sound-velocity and wind-velocity vectors.

This work was done by David W. Juergens of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 115*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
NPO-19478

Improved Determination of Si in Bi Borosilicate Glass

A flow-injection spectrophotometric method eliminates interference by bismuth.

Lewis Research Center, Cleveland, Ohio

A laboratory method that includes flow-injection spectrophotometry has been devised for measuring the silicon contents of borosilicate glasses and ceramics that contain bismuth. The determination of the concentrations of the chemical components of glasses and ceramics is essential for correlation of physical properties with chemical compositions. Numerous chemical-analysis procedures for determining the concentrations of typical chemical components of glasses and ceramics are available; some of these procedures are free from interferences, while others are subject to interferences that result in erroneously high or low values.

Inductively coupled argon plasma emission spectroscopy (ICAP) is usually reported to be free of interferences among the three primary elements (Bi, B, and Si) in bismuth borosilicate glass. However, elevated values attributable to interferences were obtained in an experiment: A series of bismuth borosilicate glasses were prepared starting with known composition, and samples of these glasses were submitted for elemental analysis by ICAP. The Bi and B values obtained in the ICAP analysis were acceptably close to the expected values, but the Si values from most samples were almost always elevated; in the worst case, the ICAP value for Si was 911 percent of the proportion (2.1 percent) used in preparing the sample. These results were unacceptable and therefore it became necessary to develop a method to make it possible to confirm the ICAP determinations.

Flow-injection spectrophotometry, on which the present method is based, is an alternative method of determining the concentrations of chemical components in a procedure that involves development of color in a carrier line, followed by spectrophotometric determination of the color. The dissolved sample is injected into a carrier line that contains one or more substance(s) that react with the sample, rendering a colored product. One of the oldest and most widely used methods for the determination of silicon in the form of silicate involves the formation of the heteropoly complex with molybdate, followed by the reduction of the complex to heteropoly blue, which is an intensely colored material. The majority of the flow-injection methods reported in the literature incorporate additional reagents for the suppression of phosphate and other interferences, but none of these methods prevents interference by precipitation of bismuth.

Figure 1 illustrates the unbalanced interference reactions along with reactions to eliminate the interferences. In the present method, the bismuth interference is eliminated in a sample-pretreatment step. The interference from hydrofluoric acid used to dissolve the sample for analysis is removed by a first carrier reagent, which contains an optimized mixture of borate and aluminum sulfate. The flow in the carrier line that contains the first carrier reagent is merged with that in a second line containing a second carrier reagent, which develops the heteropoly blue color prior to flow through the spectrophotometer cell.

BISMUTH INTERFERENCE:

$Bi^{3+} + OH^- + F^-$ or $Cl^- \rightarrow$ BiOF or BiOCl (Turbid Precipitate)

REMOVAL OF BISMUTH INTERFERENCE:

$Bi^{3+} + OH^- + EDTA^{4-} \rightarrow BiEDTA^-$ (Colorless Solution)

FLUORIDE INTERFERENCE:

$SiO_2 + F^- \rightarrow SiF_6^{2-}$

$SiF_6^{2-} + MoO_4^{2-} \rightarrow$ No Color-Forming Reaction

REMOVAL OF FLUORIDE INTERFERENCE:

$SiF_6^{2-} + BO_3^{3-} \rightarrow BF_4^- + SiO_3^{2-}$

$SiF_6^{2-} + Al^{3+} \rightarrow AlF_6^{3-} + SiO_3^{2-}$

$SiO_3^{2-} + MoO_4^{2-} \rightarrow$ Colored Heteropoly Complex

Figure 1. These **Chemical Reactions** figure in the interferences and the elimination of interferences as described in the text.

In experiments, the determinations made by applying the present method of flow-injection spectrophotometry to samples of bismuth borosilicate glass were found to be comparable to the determinations of the standard ICAP method, confirming that either flow-injection spectrophotometry or ICAP are acceptable methods for determining the concentration of Si in the presence of Bi and B. The modifications of the molybdate reagent and of sample-preparation procedure eliminate the Bi interference and the hydrofluoric acid matrix interferences in the flow-injection procedure.

The preparation of ceramics and glasses routinely includes fusion of the raw materials in crucibles made of a large

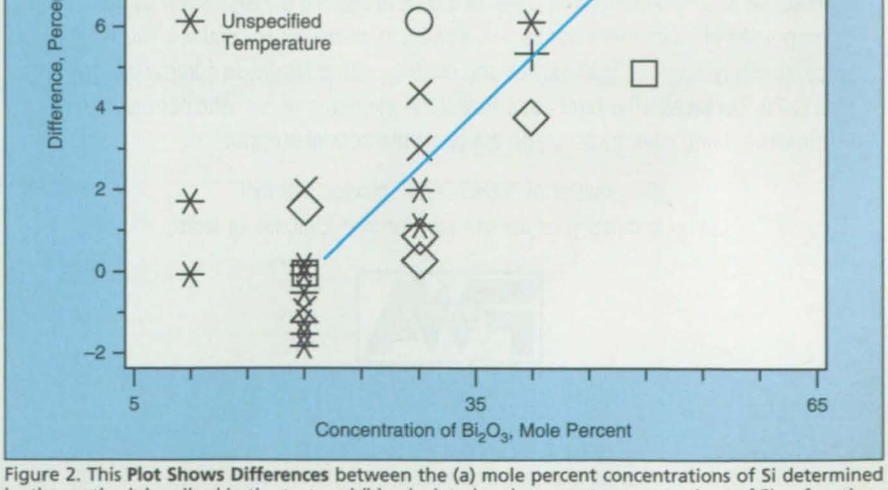


Figure 2. This **Plot Shows Differences** between the (a) mole percent concentrations of Si determined by the method described in the text and (b) calculated mole percent concentrations of Si as functions of (c) calculated mole percent concentrations of Bi_2O_3 in glass specimens that were fused at various temperatures. The solid line is a regression line through all data points for which the mole percentage of $Bi_2O_3 \geq 20$.

variety of materials. Bismuth oxide, in addition to being volatile and subliming at moderately low temperatures, is extremely corrosive in its molten state. Crucibles of platinum are dissolved by molten bismuth oxide, and graphite crucibles become degraded, causing graphite particles to be entrapped in the resulting products. Vycor (or equivalent) silica material is only partially attacked by the bismuth flux. From the extensive number of Si determinations in glass samples prepared in Vycor, it is apparent that the Bi_2O_3 content is largely responsible for elevated Si levels and that the level of elevation has a slight dependence on fusion temperature (see Figure 2).

This work was done by Frances A. Archer and Kenneth W. Street, Jr., of **Lewis Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 113*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7-3, 21000 Brookpark Rd., Cleveland, OH, 44135. Refer to LEW-16098.

Direct Time Integration of Maxwell's Equations

Propagation of optical pulses in a nonlinear medium can be simulated with high accuracy.

Ames Research Center, Moffett Field, California

The propagation and scattering of optical pulses (including electromagnetic solitons) in a nonlinear, dispersive medium can be simulated numerically by use of a method that involves direct time integration of Maxwell's equations. The time integration efficiently implements linear and nonlinear convolutions that appear in expressions for the linear and nonlinear parts, respectively, of the electric polarization of the medium.

The method can be described in terms of its application to a one-dimensional test case in which a pulse of light propagates along the x axis in an x, y, z Cartesian coordinate system into a half space ($x > 0$) filled with a homogeneous, isotropic, nonmagnetically-permeable nonlinear dielectric medium. The electric-field, magnetic-field, and electric-displacement vectors are taken to have components E_z, H_y, and D_z, respectively, where the subscripts denote the directions. The applicable set of Maxwell's equation is

$$\frac{\partial H_y}{\partial t} = \frac{1}{\mu_0}\frac{\partial E_z}{\partial x}, \quad \frac{\partial D_z}{\partial x} = \frac{\partial H_y}{\partial x},$$

$$\text{and } E_z = \frac{D_z - \left(P_{zL} + P_{zNL}\right)}{\varepsilon_0}$$

where t denotes time; ε_0 and μ_0 denote the electric permittivity and magnetic permeability, respectively, of the vacuum; and P_{zL} and P_{zNL} denote the linear and nonlinear parts, respectively, of the electric polarization along the z axis.

P_{zL} is given by the following linear convolution of $E_z(x, t)$ with the linear susceptibility function $\chi^{(1)}$:

$$P_{zL}\left(x,t\right) = \varepsilon_0 \int_{-\infty}^{\infty} \chi^{(1)}\left(t-t'\right) E_z\left(x,t'\right) dt'$$

In this case, the medium is considered to have a Lorentz linear dispersion characterized by

$$\chi^{(1)}\left(t\right) = \frac{\omega_p^2}{\nu_0} e^{-\delta t/2} \sin \nu_0 t,$$

which is equivalent to a dielectric permittivity, ε, as a function of angular fre-

quency, ω, given by

$$\varepsilon(\omega) = \varepsilon_\infty + \frac{\omega_0^{\,2}(\varepsilon_s - \varepsilon_\infty)}{\omega_0^{\,2} - j\delta\omega - \omega^2}$$

where ω_0 denotes a resonant frequency, δ denotes a coefficient of damping, and the other parameters are related by

$$\omega_p^{\,2} = \omega_0^{\,2}(\varepsilon_s - \varepsilon_\infty)$$

and

$$v_0^{\,2} = \omega_0^{\,2} - \frac{\delta^2}{4}$$

P_{zNL} is given by the following nonlinear convolution of $E_z(x, t)$ with the third-order susceptibility function $\chi^{(3)}$:

$$P_{zNL}(x,t) = \varepsilon_0 \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \chi^{(3)}(t-t_1, t-t_2, t-t_3) \times E_z(x,t_1) E_z(x,t_2) E_z(x,t_3)\,dt_1 dt_2 dt_3$$

The nonlinear convolution provides for nonlinear physical effects with time retardation or memory. In this particular case, the nonlinear properties are characterized by the following single-time nonlinear convolution:

$$P_{zNL}(x,t) = \varepsilon_0 \chi^{(3)} E_z(x,t) \times \int_{-\infty}^{\infty} \left[\alpha\delta(t-t') + (1-\alpha) g_R(t-t')\right] \times E_z^{\,2}(x,t)\,dt'$$

In this equation, $\chi^{(3)}$ becomes a constant coefficient of the nonlinear susceptibility, $\delta(t)$ models Kerr nonresonant virtual electronic transitions on the order of about 1 fs or less, $g_R(t) = [(\tau_1^2 + \tau_2^2)/\tau_1\tau_2^2]e^{-t/\tau_2}\sin(t/\tau_1)$ and models transient Raman scattering, and α parameterizes the relative strengths of the Kerr and Raman interactions. Effectively, $g_R(t)$ models a single Lorentzian spectral line that is centered on the optical-phonon frequency $1/\tau_1$ and has a bandwidth of $1/\tau_2$ (the reciprocal phonon lifetime).

The formulation of the linear and nonlinear convolutions is completed by assuming that the electromagnetic field is zero at $t \le 0$ and by defining

$$F(t) = \varepsilon_0 \int_0^t \chi^{(1)}(t-t') E_z(x,t')\,dt'$$

and

$$G(t) = \varepsilon_0 \int_0^t g_R(t-t') E_z^{\,2}(x,t')\,dt'$$

It can be shown that F and G satisfy the following coupled nonlinear ordinary differential equations:

$$\frac{1}{\omega_0^{\,2}}\frac{d^2F}{dt^2} + \frac{\delta}{\omega_0}\frac{dF}{dt} + \left[1 + \frac{\varepsilon_s - \varepsilon_\infty}{\varepsilon_\infty + \alpha\chi^{(3)}E_z^{\,2}}\right]F + \frac{(\varepsilon_s - \varepsilon_\infty)(1-\alpha)\chi^{(3)}E_z G}{\varepsilon_\infty + \alpha\chi^{(3)}E_z^{\,2}} = \frac{(\varepsilon_s - \varepsilon_\infty)D_z}{\varepsilon_\infty + \alpha\chi^{(3)}E_z^{\,2}},$$

and

$$\frac{1}{\omega_0^{\,2}}\frac{d^2G}{dt^2} + \frac{\bar{\delta}}{\bar{\omega}^2_0}\frac{dG}{dt} + \left[1 + \frac{(1-\alpha)\chi^{(3)}E_z^{\,2}}{\varepsilon_\infty + \alpha\chi^{(3)}E_z^{\,2}}\right]G + \frac{E_z F}{\varepsilon_\infty + \alpha\chi^{(3)}E_z^{\,2}} = \frac{D_z E_z}{\varepsilon_\infty + \alpha\chi^{(3)}E_z^{\,2}}$$

where

$$\bar{\delta} = \frac{2}{\tau_2} \text{ and } \bar{\omega}_0^2 = \frac{1}{\tau_1^{\,2}} + \frac{1}{\tau_2^{\,2}}$$

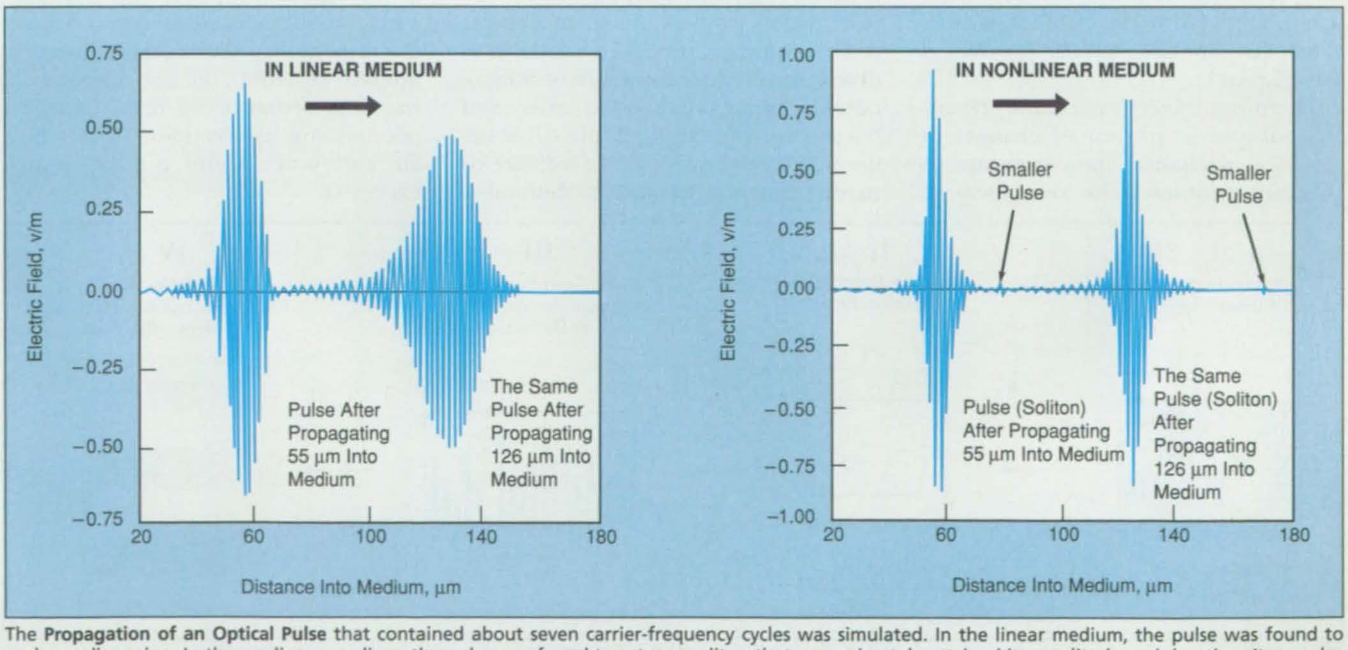
These equations are first solved simultaneously for F and G at the latest time step by use of a second-order-accurate finite-difference scheme that operates on data for the current value of D_z and previous values of D_z, E_z, F, and G. Only two time steps of storage are needed in this approach. Then the latest value of E_z can be obtained by Newton's iteration of the following equation, using the new values of D_z, F, and G:

$$E_z = \frac{D_z - F - (1-\alpha)\chi^{(3)}E_z G}{\varepsilon_0\left(\varepsilon_\infty + \alpha\chi^{(3)}E_z^{\,2}\right)}$$

Once the E_z field has been computed, H and D_z can be computed from E_z by use of Maxwell's equations. The figure illustrates some results obtained by applying this method to two versions of the test case.

This work was done by Peter Goorjian of **Ames Research Center** *and Allen Taflove of Northwestern University. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 116*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Ames Research Center; (415) 604-5104. Refer to ARC-13259.



The **Propagation of an Optical Pulse** that contained about seven carrier-frequency cycles was simulated. In the linear medium, the pulse was found to undergo dispersion. In the nonlinear medium, the pulse was found to act as a soliton that approximately retained its amplitude and duration. It was also found that a second, smaller pulse formed and moved out ahead of the main soliton pulse.

Electronic "Noses" Made From Conductive Polymeric Films

Arrays of multiple sensors would be used to distinguish among different vapors.

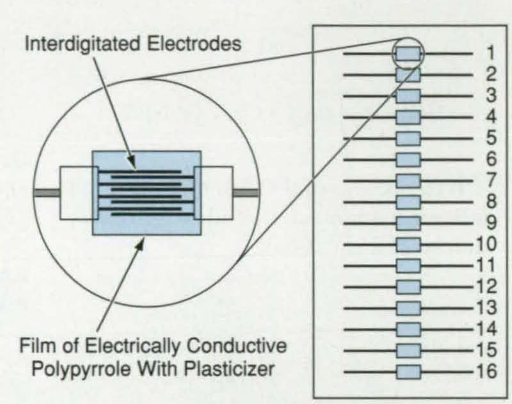
NASA's Jet Propulsion Laboratory, Pasadena, California

Broadly responsive, low-power electronic chemical-vapor sensors called "chemiresistors" are undergoing development. A chemiresistor comprises a pair of metal electrodes in contact with a thin, electrically conductive modified polypyrrole film on an electrically insulating substrate. The electrical resistivity of the film increases or decreases reversibly when the film is exposed to a chemical vapor or vapors. Multiple chemiresistors can be assembled into arrays, within which each chemiresistor is maximally responsive to a different chemical or mix of chemicals.

The film in a chemiresistor is made by chemical polymerization of a pyrrole with phosphomolybdic acid (which serves as an oxidizing and polymerizing agent), along with a plasticizer, all dissolved in tetrahydrofuran. The polymerizing solution is applied to the sensor substrate and polymerization proceeds as the tetrahydrofuran evaporates. Once polymerization is complete, the film is washed with methanol to remove excess phosphomolybdic acid and/or pyrrole monomer.

For a given film, the polymerization conditions and the concentration and type of plasticizer determine the sensory response to a given vapor chemical species or mixture; these parameters can be controlled to obtain a film with a known unique response for use in an array. Thus, an array includes sensory films that contain various plasticizers (see Figure 1).

An array produces a chemically reversible, diagnostic pattern of changes in electrical resistance upon exposure to different odorants. The resistances of the sensors in an array can be monitored, for example, by use of a multiplexing digital ohmmeter, the digital outputs of which are processed together to extract data on the concentration(s) of chemical vapor(s) in the air, somewhat in imitation of the manner in which the brain recognizes sensory patterns of odors that stimulate multiple olfactory receptors in the nose (see Figure 2).



Chemiresistor	Plasticizer
1	none
2	none
3	poly(styrene)
4	poly(styrene)
5	poly(styrene)
6	poly(α-methyl styrene)
7	poly(styrene-acrylonitrile)
8	poly(styrene-maleic anydride)
9	poly(styrene-allyl alcohol)
10	poly(N-vinyl pyrrolidone)
11	poly(4-vinyl phenol)
12	poly(vinyl butyral)
13	poly(vinyl acetate)
14	poly(bis phenol A carbonate)
15	poly(styrene)
16	poly(styrene)

Figure 1. **Multiple Chemiresistors**, each made with a polypyrrole film containing a different plasticizer, are assembled into an array for sensing a variety of chemical vapors.

The resistance readings are taken at selected times before, during, and after exposure of the sensor to air containing the vapor mixture of interest. The change (ΔR) in each resistance from its initial, preexposure value (R) is divided by the initial value, yielding a fractional resistance change ($\Delta R/R$). Then the $\Delta R/R$ values from all the chemiresistors in the array are processed together to determine the concentrations of components of vapor mixtures. As envisioned but not yet implemented, the $\Delta R/R$ values would be processed by a software or hardware neural network to determine the concentrations of components of the vapor mixture.

In initial experiments, an array of 14 chemiresistors was exposed to vapors of acetone, benzene, chloroform, ethanol, isopropyl alcohol, methanol, tetrahydrofuran, and ethyl acetate in air. Principal-component analysis of the $\Delta R/R$ responses showed that the array could be used to distinguish among these vapors and quantify their concentrations. It was also found possible to resolve the components of mixtures of ethanol and methanol vapors. The responses of the chemiresistors were complicated somewhat by temporal variations attributable to water vapor, but these complications did not adversely affect reproducibility and reversibility, and it was still possible to extract data on the responses to the organic solvents of interest. Moreover, the test environment was representative of many practical odor-sensing applications, from which air and water could not be readily excluded.

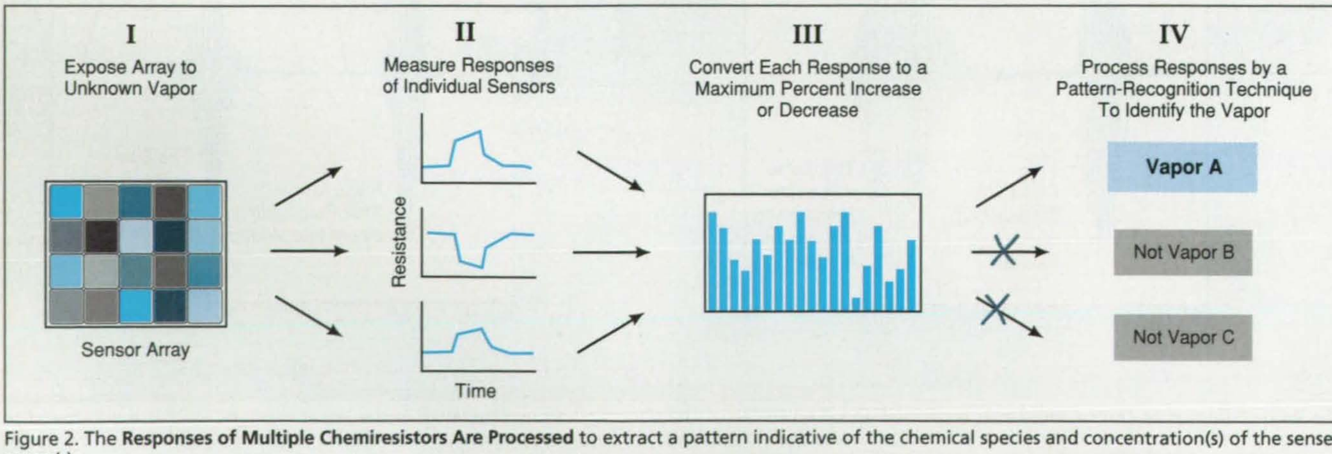


Figure 2. The **Responses of Multiple Chemiresistors Are Processed** to extract a pattern indicative of the chemical species and concentration(s) of the sensed vapor(s).

This work was done by Nathan S. Lewis and Michael S. Freund of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 103*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Larry Gilbert, Director
Technology Transfer
California Institute of Technology
Mail Code 315 - 6
Pasadena, CA 91125
(818) 395-3288

Refer to NPO-19537, volume and number of this NASA Tech Briefs *issue, and the page number.*

Quality/Flowmeter for Two-Phase Fluid

Flow speed is determined by correlating upstream and downstream capacitance measurements.

John F. Kennedy Space Center, Florida

Figure 1 illustrates a prototype instrument for measuring the volume fractions of liquid and gas and the rate of flow of a two-phase fluid. The instrument is called a "quality/flowmeter" because "quality" as used in engineering disciplines concerned with two-phase flow denotes, loosely, volume fractions of liquid or gas. Although designed specifically for measuring flows of cryogenic liquids containing bubbles of their vapors, the instrument could be readily adapted to other two-phase (including liquid/gas, liquid/liquid and liquid/solid) flows like those of water/steam, water/air, oil/water, and liquid/solid food processing mixtures.

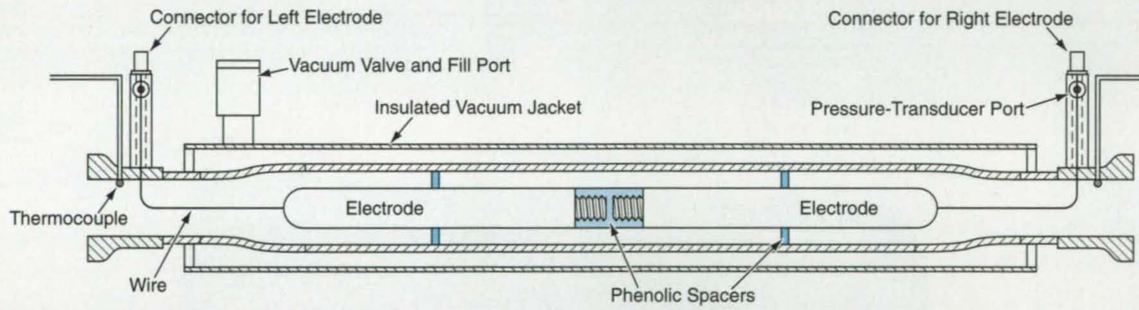


Figure 1. **Two Collinear Rod Electrodes** mounted on the axis of a pipe serve as capacitive probes for measuring the quality and speed of flow of a fluid in the pipe. A temperature and a pressure sensor provide additional information on the state of the fluid.

Like some other quality meters, this instrument is based on a capacitance-measurement concept: The fluid flows through a space between electrodes, the capacitance between the electrodes is measured, and the volume fractions of liquid and gas are computed from the effective permittivity, using the known relationships (a) between the effective permittivity and the capacitance and (b) between the volume fractions and the effective permittivity. One of the unique features of this instrument is that it contains two capacitive sensors separated from each other by a small distance along the direction of flow. The instrument is built around a section of pipe 32 in. (81.3 cm) long, with a flow cross section 2 in. (5.1 cm) in diameter at the ends. The pipe constitutes a common outer electrode for both capacitive sensors. The other electrodes for the capacitive sensors are metal rods mounted coaxially within the pipe on radial phenolic spacers and separated lengthwise by another phenolic spacer. The pipe tapers to a greater diameter along the length of the electrodes to keep the flow cross section constant along the flow path; this feature helps to minimize the effect of pressure drop. Wires connect the central electrodes to external electrical connectors. A vacuum jacket containing multilayer insulation minimizes heat transfer into the fluid.

The basic idea is to estimate the speed of flow as the quotient of the effective streamwise distance between the capacitive sensors divided by the delay between common features in the outputs of both sensors. The signal features are associated with the sizes and positions of bubbles as they move past the electrodes, and it is assumed that the velocity of each bubble closely approximates the velocity of the surrounding liquid. The two signals can be expected to have some common features — that is, the downstream signal can be expected to be an approximate, delayed version of the upstream signal — provided that the flow is not so turbulent as to alter completely the relative positions of bubbles in the interval between the upstream and downstream sensors.

The capacitance readings are sampled at intervals of less than 1 ms. Correlations between the upstream and downstream readings are computed for a range of offset times, and the delay between the upstream and downstream readings is deemed to be that offset time at which the correlation reaches its peak (see Figure 2.)

Another unique feature of this instrument is the incorporation of a temperature and a pressure sensor. The combination of quality, temperature, and pressure data enables a more nearly complete characterization of the fluid. These data can be used to estimate the density. Then the mass flow rate can be estimated from the density, the flow speed obtained from the correlation of capacitance signals, and the geometry of the instrument.

This work was done by James E. Fesmire and Rudy J. Werlink of **Kennedy Space Center** *and Kenneth A. Rose, William D. Haskell, Robert C. Youngquist, Robert B. Cox, and John S. Moerk of I-NET. For fur-*

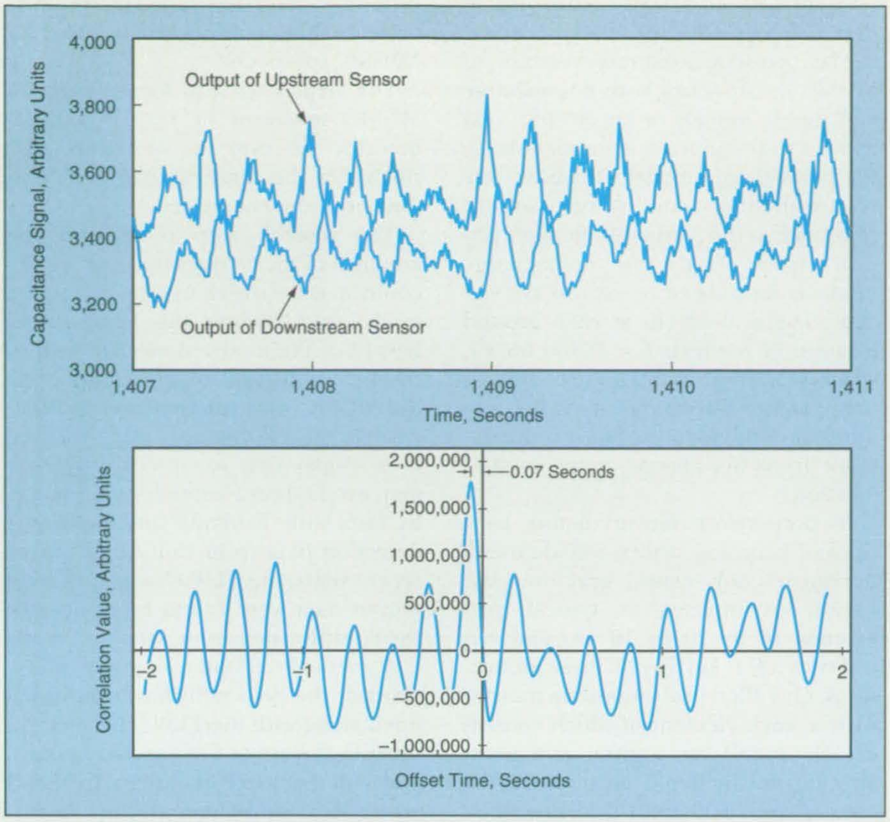


Figure 2. The **Correlation Between the Outputs** of the upstream and downstream capacitive sensors reaches a peak at an offset time of –0.07 s.

ther information, access the Technical Support Package (TSP) ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 109*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. This technology is being further developed through NASA's Dual Use Technology Development Program, where NASA and its partner, Air Products and Chemicals, Inc., are jointly funding the developmental effort. Inquiries concerning the commercial development of this technology should be addressed to the Technology Programs and Commercialization Office, Kennedy Space Center; (407) 867-3017. Refer to KSC-11725.

Identifying Electric-Charge Locations With Potential To Generate Lightning

Locations and magnitudes of charges are computed from electric-field measurements.

John F. Kennedy Space Center, Florida

The Thunderstorm Localization Workstation (TLW) is a prototype of computers that would be dedicated to predicting the locations of imminent lightning strikes within geographical regions of the order of tens of kilometers. The TLW operates at a station that receives readings from electric-field sensors, called "field mills," at 31 ground locations in an array that spans Kennedy Space Center and Cape Canaveral Air Station. The signals are enhanced by use of advanced signal-processing techniques, then inverted by use of a mathematical model of the electric field to obtain the locations and strengths of thunderstorm electrostatic-charge centers from which lightning could emanate.

The TLW software is based partly on the Multiple Signal Characterization (MUSIC) algorithm, which is an eigenanalysis algorithm that has been used in tracking radio transmitters. In the pre-

sent application, MUSIC is adapted to detect airborne electric charge centers.

The present adapted version of MUSIC incorporates both point-charge and dipole models of an electric field above a flat conductive ground. Usually, the point-charge model suffices to represent thunderstorm charge centers. Inasmuch as the field mills measure vertical electric fields, the point-charge model is formulated to express the vertical electric field (E) at each ground location of interest: $E = 2QD/(4\pi\varepsilon_0 r^3)$, where D is the altitude of the charge, Q is the amount of charge, ε_0 is the permittivity of the vacuum, and r is the distance from the charge to the ground location.

In preparation for predicting locations of lightning strikes, one defines a horizontal and vertical grid over the region of interest. A typical grid extends 10 by 20 by 10 km and has intervals of 1 km in all three dimensions. One then precomputes a transfer matrix, each element of which consists of $2D/(4\pi\varepsilon_0 r^3)$ for a given grid point and a given field-mill location. In the case of the 2,000-point grid described above and the Kennedy Space Center array of 31 field-mill locations, the transfer matrix contains 2,000 × 31 = 62,000 elements. Precomputation of the transfer matrix saves computing time, helping to make it possible to perform all other prediction computations in real time.

In the first two steps of the process, the TLW software reads data streams from the sensors and decimates the streams to a reasonable rate (typically between 1 and 10 samples per second) that is sufficient for tracking charge centers yet low enough to not contribute excessively to processing time. In the third step, the data are divided into segments between lightning strikes, segments that do not contain sensor- or field-saturation effects, and segments that do not contain sensor faults. A neural-network method is used to provide sensor-fault-detection capability beyond the capability provided by field-mill self-monitoring.

The fourth step is to determine the order of the mathematical model (in effect, the number of charge centers) on the basis of inspection of the eigenvalues of the selected segment. The fifth step is to perform the MUSIC inversion: The grid is scanned and at each point, a comparison is made between the eigenvectors of the selected segment and the eigenvectors of the transfer matrix. Good alignment between the two indicates that a charge center has been detected. The resulting three-dimensional function is called the "MUSIC spectrum."

The sixth step is to locate peaks of MUSIC spectrum by use of a peak-detector run over the spectrum. This run yields the three-dimensional coordinates of the charge centers.

The seventh step is to find the amounts of the charges by inserting the coordinates of the charge centers in the model and finding the least-squares best fit of the modeled electric field to the field-mill data. In the eighth step, the MUSIC spectrum and the location and charge information are presented in a display that resembles a weather map overlaid on a weather-radar image. In tests with field-mill and lightning-detection data from thunderstorms of recent years, the TLW charge-detection output data were found to agree with the lightning-detection data.

A method of optimizing the placement of the field mills has been developed along with the TLW. This method involves the use of Cramer-Rao bounds, and can be used to design field-mill arrays for other geographic areas. Cramer-Rao analysis has also shown that sometimes a vertical-dipole model performs better than the single-point model described above. Thus, it would be desirable to develop a computational method of distinguishing between single-point and dipole charges. Investigations using neural nets for localization and wavelets for signal segmentation show promise as future areas of research.

This work was done by Chris Berthold, Timothy M. Rynne, Kim J. Olszewski, and John T. Robinson of Scientific Applications & Research Associates, Inc., for **Kennedy Space Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 111*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

John T. Robinson
Scientific Applications & Research Associates, Inc.
15262 Pipeline Lane
Huntington Beach, CA 92649
(714) 373-5509

Refer to KSC-11859, volume and number of this NASA Tech Briefs *issue, and the page number.*

Electronics TECH BRIEFS

Electronic Programming of Analog Devices

Improved Focusing Schlieren System

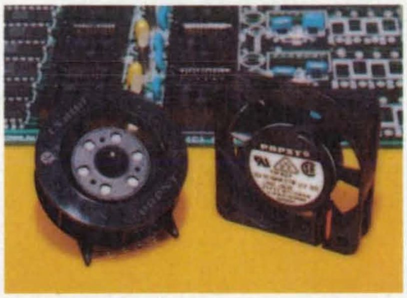
Capacitive High-Voltage Sensors

New Electronics Products — see page 17a

1 Standard Fan Tray Choice of 55 Standard Fans

Now, ebm/Papst offers one standard fan tray with your choice of fifty-five brushless DC or AC fan models. Air flows 50 to 108 CFM. Terminations to meet your needs. Custom trays also available.

Board Level Air Movers, Fans or Motorized Impellers



Miniature fans from ebm/Papst have the same quality and performance as the rest of our complete product line. These 40mm fans and motorized impellers solve board level problems.

FREE Fan & Blower Catalog

GET YOUR COPY NOW! ebm/Papst offers a complete line of Fans & Blowers. This easy-to-read, easy-to-use 200-page catalog offers brushless DC and AC products for all kinds of air moving applications.

The POWER OF COOL continues to lead the industry with the products, engineering and service to meet our customers' most demanding requirements. ebm/Papst offers all types of standard fans and blowers, plus the application engineering and manufacturing versatility to offer value-added, packaged cooling in FlatPak's™, Fan Trays or Flo-Thru Modules™. ebm/Papst is an ISO 9001 supplier with the ability to meet the most stringent quality and scheduling requirements, or simply ship a single order. Call today for information or a full-line catalog. Ask for an application engineer if you have a specific need.

For More Information Circle No. 450

ebm PAPST

ebm/Papst
110 Hyde Road
Farmington, CT 06034
Phone: 860-674-1515
Fax: 860-674-8536
e-mail: sales@ebm.com
Internet: http://www.ebm.com

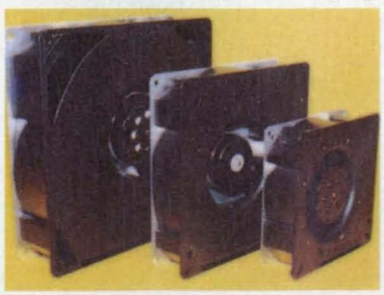
Backward Curved Impellers offer Quiet Versatility

Quiet operation without a scroll housing. 360° airflow. Higher efficiencies and quieter operation than most other air movers. AC or brushless DC. Mount in Flo-Thru Modules™ for easy assembly.

Tubeaxial Fans, 40mm to 225mm, AND Everything in between!

ebm/Papst offer the widest range of brushless DC and AC tubeaxial fans in the world. Plus all kinds of other air moving products. Application engineers always available, 860-674-1515. Most products are in stock, ready to ship.

FLATPAK's = Spot Cooling



A great answer for spot cooling, or shallow, tight fits. FLATPAK's are quiet, efficient and good for moving air against higher static pressures. FLATPAK™ blowers mount in any position. DC or AC models.

Electronics TECH BRIEFS

Electronics Tech Briefs Supplement to *NASA Tech Briefs* July 1997 Issue Published by Associated Business Publications

ELECTRONICS TECH BRIEFS

DEPARTMENTS

On the cover:
Analysis of an individual die on a hybrid microcircuit. Assessment of thermal performance helps characterize the cooling efficiency of different combinations of substrate materials and attachment methodologies. Photo courtesy of FLIR Systems Inc., Portland, OR.

NEWS BRIEFS

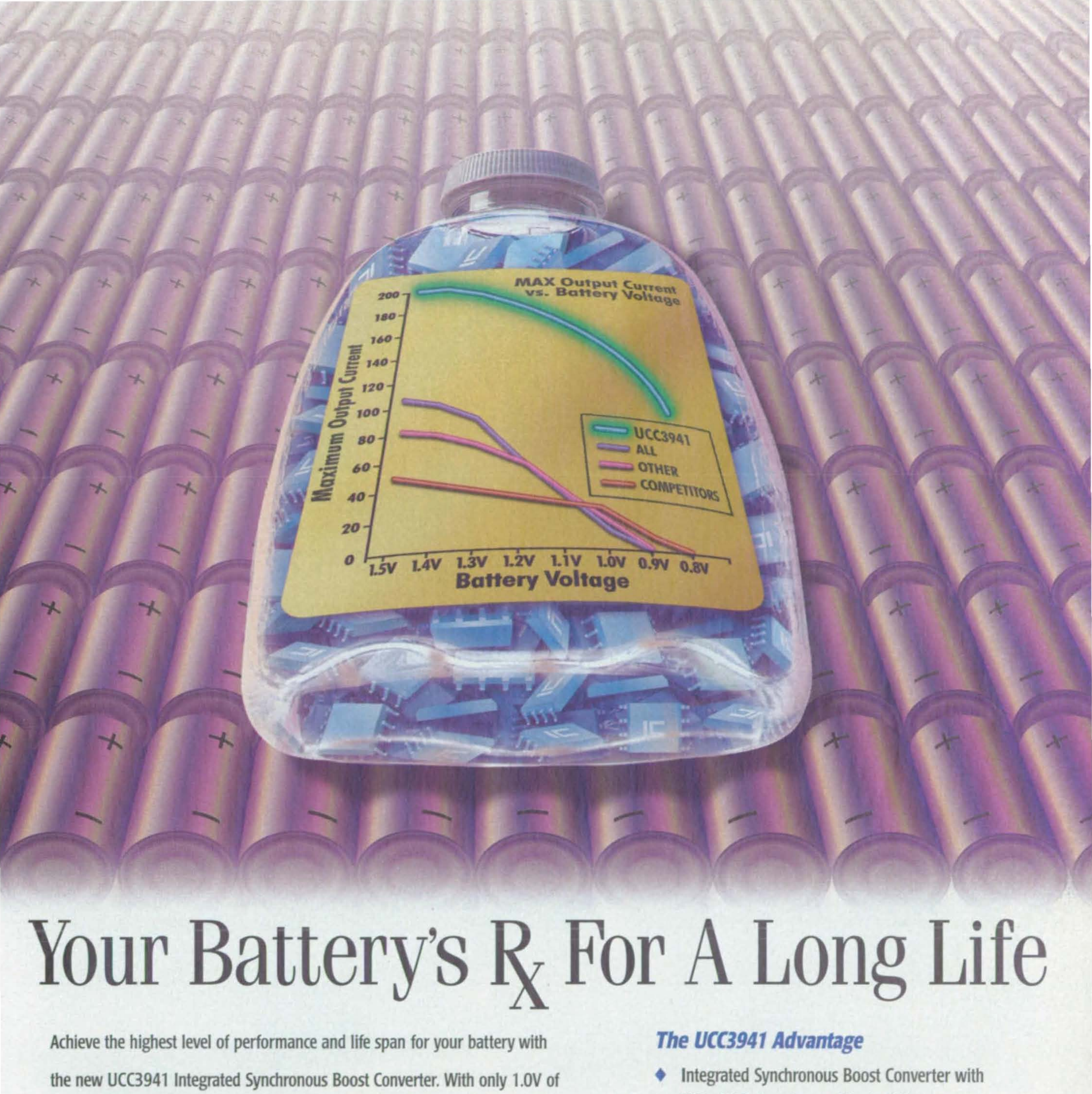
Notes from Industry and the Federal Laboratories

NASA Headquarters awarded **Space Electronics Inc.** of San Diego, CA, a Phase I research contract under the Small Business Innovation Research (SBIR) program to evaluate the technical feasibility of radiation hardening of commercial microelectronics for space with the company's proprietary Single Event Latchup Protection technology. The contract will be administered by **Jet Propulsion Laboratory** of Pasadena, CA, and all research will be performed at the company's San Diego laboratory.

Princeton Instruments Inc. (PI) of Princeton, NJ, announced that it has been acquired by **Roper Industries** of Bogart, GA, for an undisclosed sum. Dr. Yair Talmi, PI's founder, will become a consultant to the company, which plans to remain a leading supplier of cooled CCD cameras for spectroscopy and many applications in scientific digital imaging. John West, formerly CEO of PI, will become its president. Roper Industries has been expanding its analytical instrumentation group, which includes **Gatan**, a prominent manufacturer of cooled CCD cameras for transmission electron microscopy, and **Molecular Imaging**, which makes atomic force microscopes. Roper, which is listed on the New York Stock Exchange, is expected to bring increased financial resources to PI, enabling the company to continue its growth. PI will remain at its current address: 3660 Quakerbridge Rd., Trenton, NJ 08619; (609) 587-9797; FAX (609) 587-1970.

New Wave Research of Sunnyvale, CA, received a U.S. patent (5,611,946) for the multiwavelength laser system and probe system that the company utilizes in its LCS II, LCS III, and QuikLaze laser micromachining systems. Used primarily for semiconductor failure analysis and liquid crystal display repair, the small flashlamp-pumped Nd:YAG lasers operate at 1064, 532, and 355 nm. Ed North, a spokesman for the company, cites as the lasers' uniqueness the ability to select the wavelength with the flip of a switch or computer command rather than changing laser heads or manually inserting dichroic mirrors and harmonic generators. North says that the patent also encompasses a motorized energy attenuator that allows precise control of laser energy at each wavelength. The company sold its 1000th Nd:YAG laser system in May, and nearly half of those sales have been multiwavelength systems used in semiconductor, LCD, and particle image velocimetry applications.

The nation's timekeepers, the **National Institute of Standards and Technology's Time and Frequency Division** in Boulder, CO, and the **U.S. Naval Observatory** in Washington, DC, are spreading the word that this summer will be the longest one since 1994. The reason is that on June 30 the two labs, along with operators of standard clocks in all of the world's scientifically developed countries, added a leap second to keep the world's atomic clocks synchronized to Earth's rotation. This marks the 21st such worldwide adjustment since 1972, as decreed by the International Earth Rotation Service in France. The adjustment is needed because, though the best of advanced clocks such as those at NIST and USNO lose or gain much less than a millionth of a second in a year, the Earth's rotation varies several thousandths of a second each day. The last leap second was on December 31, 1995, and the last summertime leap second was on June 30, 1994.


MAX Output Current vs. Battery Voltage
Maximum Output Current
200
180
160
140
120
100
80
60
40
20
0
1.5V 1.4V 1.3V 1.2V 1.1V 1.0V 0.9V 0.8V
Battery Voltage
UCC3941
ALL
OTHER
COMPETITORS

EPAD–Electronic Programming of Analog Devices

Programming of analog ICs enables precision, versatile trimming of analog circuits.

Advanced Linear Devices, Sunnyvale, California

Trimming of analog circuits traditionally has utilized mechanical variable resistors (trimpots). Although practical from a parts-cost point of view, this method has several disadvantages, including large size, high labor cost, instability, and the difficulty of remote implementation. With the advent of the microprocessor, an alternative method has been employed using microcontrol circuitry. This system is versatile but requires a high material cost. A new technology called EPAD (electrically programmable analog devices) electrically programs analog ICs that are functioning components of an analog circuit. This allows for low-cost precision trimming of analog circuits, since material and labor is minimized. It is also versatile, being compatible with both engineering-lab and production-line procedures, and enables remote trimming of circuits in various ambient and field conditions.

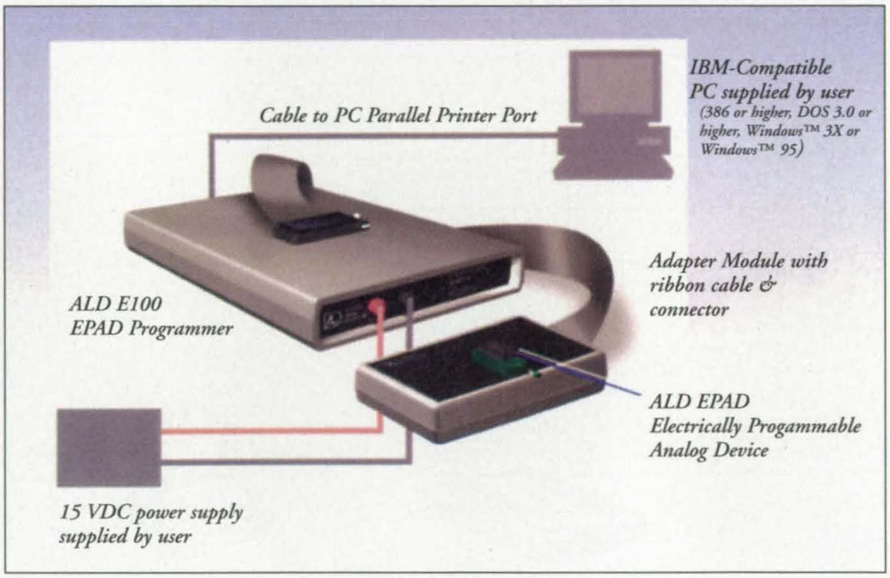
EPAD devices are a new class of CMOS integrated circuit that allows for the bias voltage of MOSFET transistors, embedded in the IC, to be programmed. The programming is accomplished via the use of an inexpensive, specially designed programmer, an IBM-compatible PC, and an adapter module that is compatible with the particular EPAD device being programmed. Various configurations of such devices are possible from simple dual MOSFET transistors to operational amplifiers. Standard programming software allows for basic variations in circuit performance, but users are free to establish varied and specific applications by developing their own software and adapter module hardware.

EPADs can be programmed in up to 2000 discrete steps with a resolution of 0.001 volt. Programming is achieved through a series of software-controlled rapid-fire bursts of voltage, and is monotonic. This means the device can be programmed to successively higher voltage levels, but not lower. Bidirectional programming can be achieved, however, by utilizing the EPADs in pairs. One device can be incorporated into a simple circuit to always lower voltage and the other to always increase it, thus allowing for bidirectional programming. Once programmed, the voltages are fixed and stable, and cannot be altered, even under power-off conditions.

The programmer is a low-cost unit that interfaces with a standard IBM-compatible PC (386 or higher, with DOS 3.0, Windows 3x or Windows 95) via the parallel printer port. The programmer contains control logic, a precision analog-to-digital converter, a program pulse counter, a switch matrix, and the circuitry required to make precise voltage measurements. Connection to the programmer is accomplished via adapter modules, into which the EPAD is inserted, with individual programs that are specially configured for each EPAD device. DOS-based software allows custom programming of the control application software, written in Quick Basic. The interface software contains two windows, a parameter-setting window and a programming window. Users can develop unique programs to allow for automatic and custom programming of their entire circuit or system. For instance, a desired circuit or system output could be established and a software program devised to automatically program an EPAD device to give this output.

EPAD integrated circuits are factory-set to nominal threshold voltage levels. Users first measure the threshold voltages via the programmer and PC, where the voltages for each transistor are displayed to the nearest ten-thousandth of a volt. Each channel can then be selectively and individually programmed, via the PC keyboard, in increments of 0.001 V. Values are displayed in real time to verify that the programmed voltage levels are realized in each transistor.

EPAD units can be programmed as standalone units, before they are put into a circuit, or in the system after the assembly has been built. This allows trimming circuits at various environmental conditions. For example, EPADs may be used to provide trimming of various battery-operated instruments that may experience varied ambient conditions. In such cases the device can be programmed in an environmentally controlled chamber, or hostile field conditions. EPAD programming is compatible with engineering laboratory instruments and software programs, making it well suited for research and circuit development procedures. It is also very applicable to production, since trimming of an analog circuit or system can be preprogrammed and completed as a final step after assembly. The procedure is rapid and inexpensive. For instance, circuits that are encapsulated into modules can be trimmed without destroying the integrity of the epoxy case, thus maximizing yield, cost, and reliability.



Schematic of Advanced Linear Devices' **E100 EPAD Programming System**.

Development work on EPAD was completed by **Advanced Linear Devices**, *Sunnyvale, CA, under the direction of President Robert Chao. For additional information, fax Richard Koury, Marketing Manager, at (408) 747-1286. Patents have been applied for. Inquiries regarding licensing of this technology should be directed to Advanced Linear Devices, 415 Tasman Dr., Sunnyvale, CA 94089.*

SONY

The world's most advanced data recorders?

(All DAT and more, SIR.)

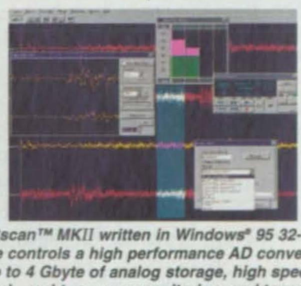
Who but Sony could pack speed, range, density, features, and above all, portability, in such small packages. But rugged enough for the toughest field jobs. With multiple power capability: AC, DC, and battery. And, they perform, with individual per channel A/D conversion and 16 bit linear quantization for exceptional data resolution and high dynamic range (80dB or greater). Exceptional data with interchannel phase error of less than 1°. Choose the DAT or even higher capacity SIR series. It's just a matter of how many channels and how much data you require.

DAT PC200Ax Series

- Up to 20 kHz analog bandwidth (100 kHz/PCHB244).
- Up to 3 Mbps digital bit stream recording (mix analog and digital channels on the PCHB244!).
- Multiple channel configurations from 2 to 64 channels.
- A wide range of voltage inputs.
- Up to 6 hours of data storage (4 Gbytes).
- Complete computer integration for remote control.
- Supports Data Transfer from most DAT tapes.

AIT SIR-1000

- 20 kHz analog bandwidth per channel on 16 or 32 channels (up to 256 channels at 5 kHz).
- Digital bit stream recording to 24 Mbps.
- The new Sony AIT (Advanced Intelligent Tape) and drive stores 25 Gbytes.
- Up to 32 hours recording duration per data cartridge.
- Variable speed record and playback minimizes data reduction time.
- Triggered recording with pre-trigger, re-write error correction, standard voice and IRIG time code channels, optional SCSI fast & wide data interface.



PCscan™ MKII written in Windows® 95 32-bit code controls a high performance AD converter, up to 4 Gbyte of analog storage, high speed search, real-tme wave monitoring, and tape data format conversion. That means improved data measurement. And dat's DAT.

Sony Precision Technology Inc.
Toyo Building, 9-17, Nishigotanda 3-chome,
Shinagawa-ku, Tokyo, 141 Japan
Phone: +81 (3) 3490-3943
Fax: +81 (3) 3490-4674

Sony Precision Technology America, Inc.
137 West Bristol Lane
Orange, CA 92865 USA
Phone: (714) 921-0630
Fax: (714) 921-1162

Sony Precision Technology Europe GmbH
Stuttgarter Strasse 106
D-70736 Fellbach, Germany
Phone: +49 (711) 5858-253
Fax: +49 (711) 580715

http://www.sony.co.jp/InterChange/spt/corp.html

For More Information Circle No. 456

Polarization-Insensitive Electro-Optical Modulator Systems

Costs of light-wave communication systems could be reduced.

NASA's Jet Propulsion Laboratory, Pasadena, California

Electro-optical modulator systems of two proposed types would be insensitive to polarization; that is, variations in the polarization states of the input light waves to be modulated would not give rise to variations in the power levels of the output modulated beams. These modulator systems would be desirable in lightwave communication systems, including fiber-optic telephone, cable-television, and millimeter-wave communication systems, plus future personal mobile communication systems.

The commercial electro-optical modulators in current use are sensitive to polarization, making it necessary to take great care to ensure correct and stable polarizations in order to obtain stable outputs. This, in turn, necessitates the use of polarization-maintaining optical components — including, in many cases, polarization-maintaining optical fibers. In comparison with ordinary single-mode optical fibers, polarization-maintaining optical fibers cost about 20 times as much and are more difficult to handle; these characteristics contribute significantly to the high cost of present lightwave communication systems. Moreover, sensitivity to polarization precludes the use of single-mode optical fibers in the field, thereby inhibiting the establishment of the superior lightwave communication systems that could be built around electro-optical modulators. Because of their insensitivity to polarization, the proposed modulator systems would decrease the cost and increase the feasibility of such systems.

The upper part of the figure schematically illustrates a proposed polarization-insensitive modulator system of the first type. The incoming lightwave to be modulated would first pass through a polarization beam splitter, which would decompose the beam into two beams in orthogonal polarization states. The two orthogonally polarized lightwaves would pass through separate electro-optical modulators driven by the same signal. The outputs of these modulators would be directed into a polarization beam combiner, where they would be recombined into a single output lightwave.

The power of each polarization going into its respective modulator would depend on the angle of polarization, θ, of the input wave. However, the power of the output wave could be made independent of θ. Starting from the basic equations for the behavior of the various polarization components, it can be shown that if the two modulators were identical, then the power, P_{out}, of the output beam would be given by

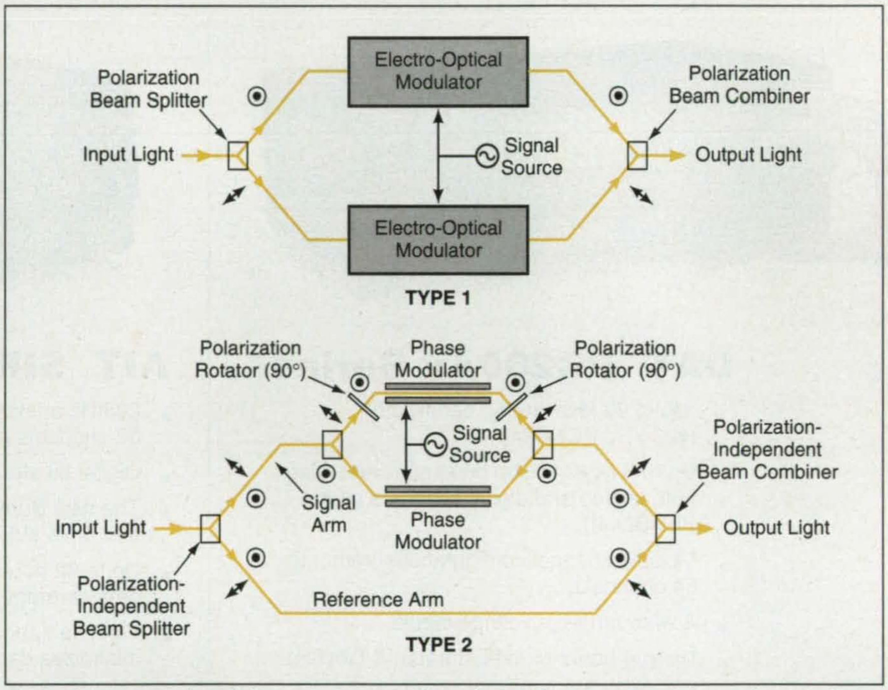
$$P_{out} = \alpha P_{in}\{\cos[\phi(V(t))+\phi_0]\}^2,$$

where α is a transmission factor, P_{in} is the power of the input beam, $\phi(V(t))$ is the variation in phase angle as a function of the time-varying modulation voltage $V(t)$, t is time, and ϕ_0 is an initial phase determined by the bias voltage applied to the modulators.

Finally, the light from the reference and signal arms would be recombined in the output polarization-independent beam combiner. If the phase modulators in the signal arm were identical, then the output power would again be independent of θ and would be given by

$$P_{out} = (P_{in}/2)\{\alpha_r+\alpha_s\cos[\phi_s(V(t))+\phi_{s0}-\phi_r]\},$$

where α_r and α_s are transmission factors for the reference and signal arms, respectively; $\phi_s(V(t))$ is a modulation function like that described above, and ϕ_{s0} and ϕ_r are initial phase angles for the signal and reference arms, respectively.



These **Electro-Optical Modulator Systems** would produce output signals with power levels independent of the polarization angles of the input light, provided that in each system, the modulators were identical.

The lower part of the figure illustrates a proposed polarization-insensitive modulator system of the second type. A polarization-independent beam splitter would split the incoming light into two parts of equal power and identical polarization states. One of these light waves would be directed along an optical path called the "reference arm," where it would travel directly to an output polarization-independent beam combiner. The other part would be directed along an optical path called the "signal arm," where it would be split further into orthogonally polarized waves that would be phase-modulated by the same signal, then recombined.

This work was done by Xiaotian Steve Yao of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 158*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Resident Office–JPL; (818) 354-5179. Refer to NPO-19430.

One-Sided Focusing Schlieren System With Reflective Grid

All of the focusing optics are located on one side for compactness.

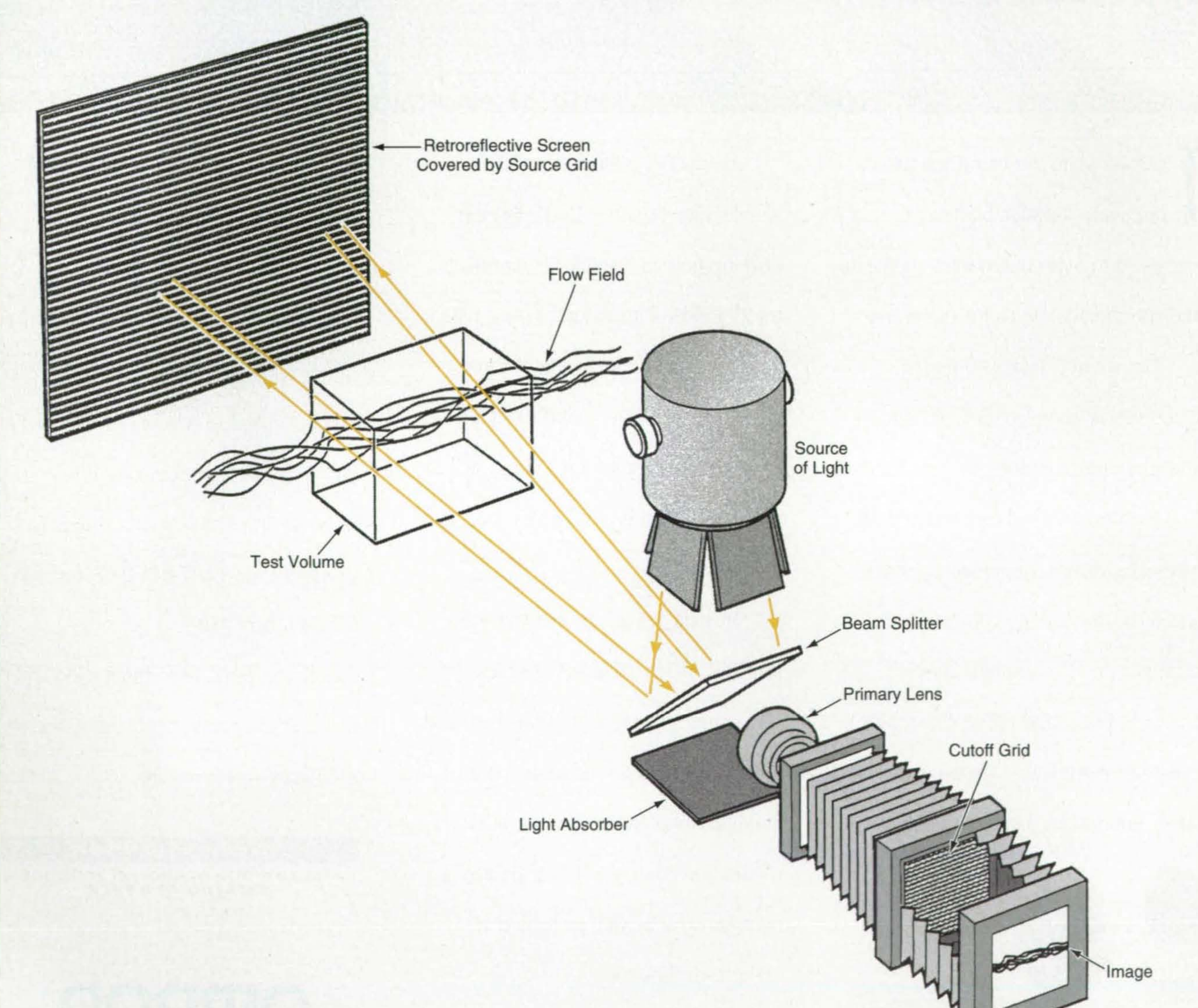
Ames Research Center, Moffett Field, California

In an improved focusing schlieren system designed especially for observing flow in a wind tunnel, all of the focusing optics are located on one side of the volume to be observed (test volume), instead of on both sides as in older schlieren systems. Thus, most of the instrumentation can be mounted in a compact aerodynamic housing that perturbs the flow minimally and that can be positioned within the wind tunnel to obtain the required view of the observation volume.

The immediate predecessor to the improved system is a two-sided focusing schlieren system that utilizes grids instead of the knife edges of classical focusing schlieren systems. In the predecessor system, an illuminated Fresnel lens and frosted glass serve as a bright, diffuse source of light on one side of the test volume. A source grid lies between the Fresnel lens and the test volume. A camera located on the opposite side of the test volume faces the source grid, and a cutoff grid (the photographic negative of the source grid) interacts with the image of the source grid as modified by refraction in the test volume to provide the schlieren image. This image reveals gradients in the index of refraction and thus gradients of density in the flow in the test volume.

In the improved system, the source of light of the predecessor system is replaced by a screen of retroreflective material like that used in automobile license plates and road signs. The retroreflective material contains prismatic particles that reflect light diffusely but with greatest intensity back along the path of arrival. A source grid is laid over the retroreflective screen. The grid-covered screen is mounted on one side of the test volume; it can be conveniently mounted on the wall or ceiling of the wind tunnel.

The other optical components of the system, including the cutoff grid, camera, and source of light, are mounted in an aerodynamic housing on the other



The **Retroreflective Screen** reflects light predominantly along the path of illumination through the source grid. The light passes through the flow field into the camera lens. Optionally, the beam splitter can be removed and the source of light can be placed alongside the camera and aimed parallel to the optical axis of the camera to illuminate the test volume and the retroreflective-screen/source-grid combination.

side of the test volume (see figure). By use of a beam splitter, the source of light can be made to illuminate the screen and source grid along the optical axis of the camera. The retroreflective screen directs the light back along the same path through the source grid, and the schlieren image is formed in the same way as in the predecessor system. One side benefit of this arrangement is that instead of being silhouetted by back lighting as in older schlieren systems, objects in the test volume are illuminated from the camera side and, as a consequence, their details and interactions with the flow can be viewed more readily.

A tabletop model of the system was built to test its design. The model included an *f*/5.6 camera lens with a 300-mm focal length. The model exhibited a sensitivity of less than 9 arc seconds, which is comparable to that of a conventional schlieren system. The system had a depth of focus of less than 13 mm. A system of similar design was tested in the NASA Ames 7 × 10-ft (2.1 × 3-m) wind tunnel.

This work was done by James T. Heineck of **Ames Research Center** *and Stephen M. Jaeger of Sterling Federal Systems. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 125*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention has been patented by NASA (U.S. Patent No. 5,515,158). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Ames Research Center; (415) 604-5104. Refer to ARC-13391.

Capacitive High-Voltage Sensors for Phase-Locked High-Voltage Supply Control Systems

Advantages include easy interface to digital or phase-locked control systems.

Vandiver Electronics, Huntsville, Alabama

Readily available high-voltage capacitors with X7R dielectrics have been incorporated into radio-frequency oscillator circuits to form high-voltage-controlled oscillators (HVCOs) whose output frequency varies with applied voltage. The high-voltage capacitors form part of a radio-frequency oscillator tank circuit along with center-tapped winding on a toroidal inductor. The use of a center-tapped tank winding along with two sense capacitors allows the high-voltage input to be applied to an RF ground point, so that very little RF energy is leaked into the high-voltage system, and also serves to make the oscillator insensitive to the impedance presented by the high-voltage supply being monitored. The center-tapped tank circuit is coupled to the remainder of the oscillator electronics by another winding on the same core, as shown in Figure 1.

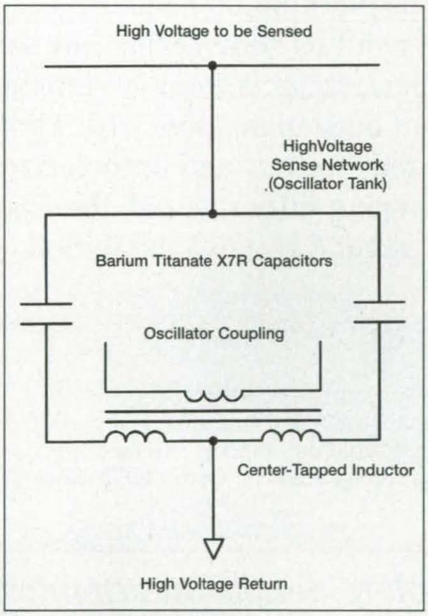


Figure 1. **HVCO Tank Circuit.**

The advantages of a capacitive sensor include no power dissipation from the high-voltage supply output for steady-state outputs, easy isolation of high-voltage and low-voltage grounds, and easy interface to digital or phase-locked control systems. The HVCO is also simpler to implement than some other nondissipative means of sensing a high-voltage output, such as electro-optic cells.

Since the capacitors in the HVCO are sensitive to temperature as well as voltage, a given HVCO must be characterized over the expected ranges of temperature and high-voltage bias to be encountered during operation. The HVCO also presents an additional capacitance to the output of a high-voltage stepping supply, and some additional current is required from the high-voltage supply during output step changes.

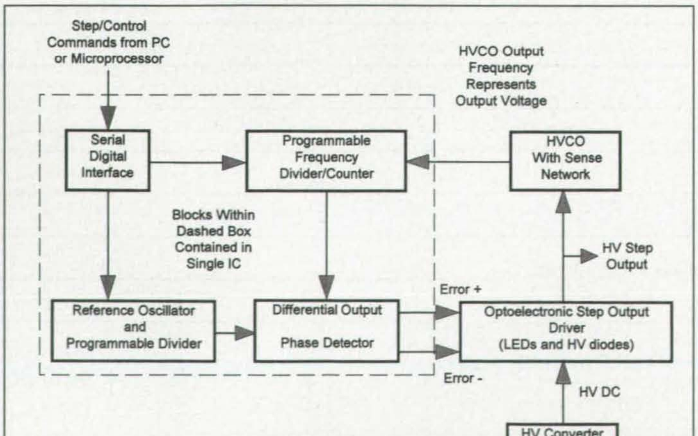


Figure 2. **Phase-Locked High-Voltage Control System.**

The HVCO circuit has been tested successfully in a prototype phase-locked loop (PLL) control system for a high-voltage stepping supply. A system block diagram is shown in Figure 2.

A commercial PLL frequency synthesizer IC formed the main control circuit in this system. A quartz crystal provided a stable clock reference for the system. The phase detector outputs from the PLL chip were buffered and used to drive infrared LEDs, which produced photocurrents in reverse-biased high-voltage diodes in an optoelectronic high-voltage output stage. The HVCO was used to provide feedback to the PLL from the high-voltage output. High-voltage steps were determined by programming the PLL chip frequency dividers through a serial digital interface.

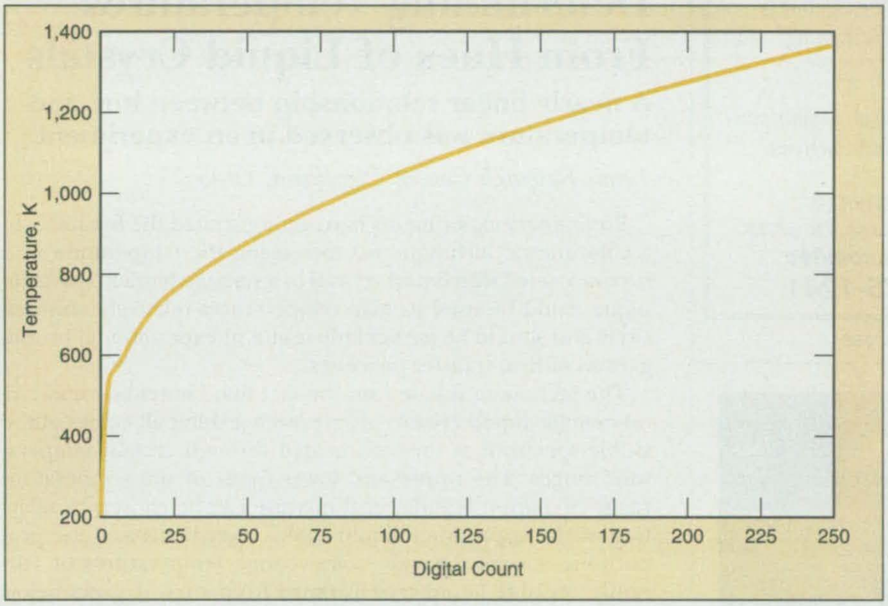
This work was done by James C. Vandiver of **Vandiver Electronics** *for NASA's Planetary Instrument Definition and Development Program (grant no. NAGW-4595). For more information, contact Vandiver at 741 Chase Rd., Huntsville, AL 35811; (205) 851-7712; Vandiver@unhesp.sr.unh.edu*

First-Order Modeling of a Radiometer in Mathcad

The model can be adapted to almost any design requirements.

Stennis Space Center, Mississippi

A first-order mathematical model of an infrared radiometer functioning as a temperature sensor has been created within the Mathcad software framework. The model is a useful computational tool for designing and analyzing the performances of radiometers. The model provides easy access to the primary design parameters of a radiometer and enables the user to manipulate conditions to fit a wide range of applications.



Temperature vs. Digital Count was computed for the lookup table in a test case.

In the model, the target (the object, the temperature of which one seeks to measure) is assumed to radiate according to Planck's radiation law as a gray body of known emissivity. The target is assumed to fill the field of view of the radiometer. The detector in the radiometer is assumed to be a thermopile with a response that is spectrally flat and linear with input (this linearity is known to be only an approximation). Other simplifying assumptions (involving various degrees of approximation) include that no correction for ambient temperature is necessary, that the spectral transmittance of the intervening atmosphere and the radiometer optics are uniform over all wavelengths, that there is no reflected radiation and no atmospheric or other radiance coming from sources other than the target, and that for purposes of computing the integral of spectral response of the radiometer over all wavelengths, the pass band of the radiometer can be represented by a trapezoidal response-vs.-wavelength plot.

The transmittance of the intervening atmosphere and radiometer optics are specified by the user. In the model, these parameters are lumped into one transmittance value, which is multiplied by the gray-body spectral radiance for a given target temperature and integrated over the pass band (which can also be specified by the user) to obtain the radiance at the detector. The response (output voltage) of the detector to this radiance is estimated from the detector specifications.

The output of the detector is assumed to be fed through an amplifier to an analog-to-digital converter (ADC), the output of which is used to address an electronic memory that implements a lookup table of temperature vs. digital count (see figure). The model computes the amplifier gain needed to maximize resolution for the case of an 8-bit ADC with an input-potential span of 5 V. The model further computes the digital counts for the highest and lowest expected levels of radiance. The combination of counts and radiance is used to obtain a linear system transfer equation, which, in turn, is used to compute the count-to-temperature lookup table.

The Mathcad software framework makes it possible to relax some of the simplifying assumptions by incorporating the applicable spectral transmittances, reflectances, detector parameters, and/or other detailed information as needed. Thus, the model can be adapted to a more rigorous analysis to satisfy almost any design requirements. The model was created in Mathcad version 3.1 for UNIX, and can be implemented in any Mathcad version 3.0 or later.

This work was done by Bruce A. Spiering of **Stennis Space Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 168*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the NASA/SSC Technology Transfer Office, (601) 688-2346. Refer to SSC-00043.

Determining Temperatures From Hues of Liquid Crystals

A nearly linear relationship between hue and temperature was observed in an experiment.

Lewis Research Center, Cleveland, Ohio

Preliminary experiments have demonstrated the feasibility of a colorimetric technique for measuring the temperature of a surface coated with liquid crystals in a suitable binder. The technique could be used to map temperatures relatively noninvasively and should be particularly useful in experimental investigations of heat-transfer processes.

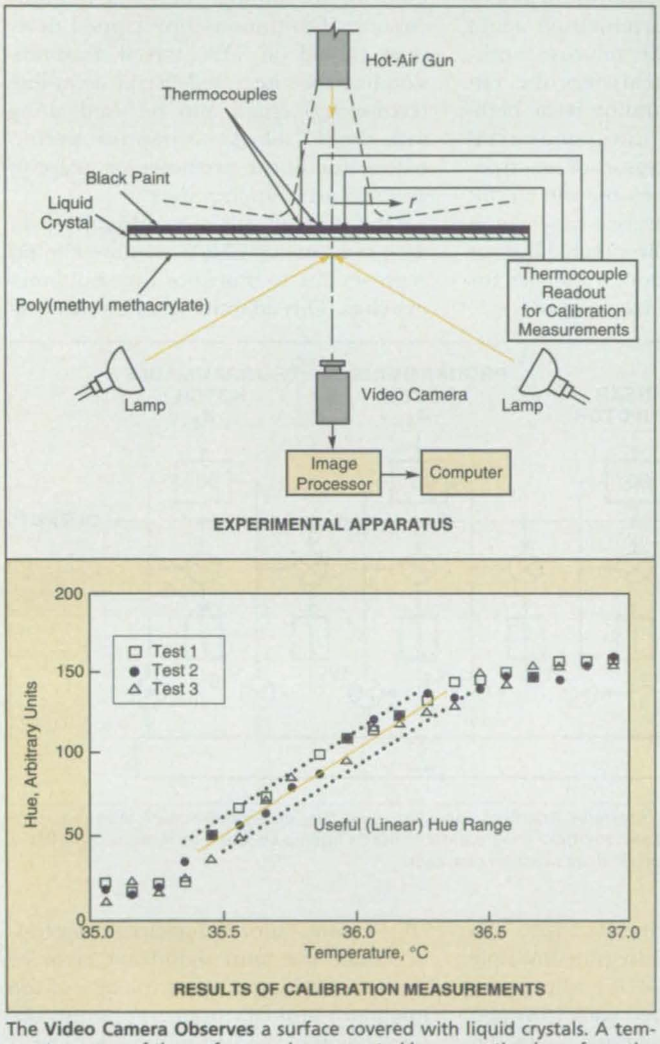
The technique is based on the fact that cholesteric and chiral-nematic liquid crystals progressively exhibit all colors of the visible spectrum as they are heated through certain temperature ranges. The upper and lower limits of the temperature range of a given liquid-crystal mixture can be chosen by selection of the appropriate liquid-crystal ingredients and the proportions thereof. Overall, color-change temperatures of currently available liquid crystals range from a few degrees below zero to several hundred degrees centigrade, and the color-change range of a liquid-crystal mixture can be made as narrow as 1 °C or as wide as 50 °C.

Though the implementation of the technique involves attention to the many details that affect any colorimetric scheme, the basic principle of operation is simple. The surface to be observed would be coated with a liquid-crystal mixture formulated to change color over the temperature range of interest. The object would be observed by a color video camera. The output of the video camera would be fed to an image processor and computer, which would compute a quantitative measure of the hue of each picture element from the red, green, and blue video signals from that picture element. Then by use of a known relationship between the hue measure and temperature (determined previously by calibration measurements at known temperatures), the temperature of the surface point represented by each picture element could be computed. Picture elements at the same temperature could be connected by lines to form isotherms, generating a temperature-contour map of the observed surface.

The upper part of the figure illustrates schematically an apparatus used to demonstrate the technique. The lower part of the figure presents the results of a set of measurements taken on the apparatus. These results confirm the close correspondence between hue and temperature for the particular liquid-crystal

tested: particularly noteworthy is the nearly linear change of hue from 35.3 to 36.3 °C. This linear range spans the visible spectrum from red to blue, and the uncertainty band around any given hue value in the linear range is about 0.1 °C wide.

The preliminary experiments also showed that, as one would expect, the hue-vs.-temperature relationship can change slightly with intensity of illumination and can change to a greater degree with the angle of illumination. Therefore, to minimize the uncertainty in the measurement of temperature, one should set the lamps at the same distance and angle from the observed surface during both calibration and subsequent measurements to determine unknown temperatures. Also to minimize the uncertainty, one should keep all camera adjustments (gain, zoom, aperture, and the like) and all image-processor color-capturing adjustments the same during calibration and subsequent measurements.



The **Video Camera Observes** a surface covered with liquid crystals. A temperature map of the surface can be generated by computing hues from the color video output and by using the relationship between temperature and the hue of the liquid crystals.

This work was done by Cengiz Camci of Pennsylvania State University and Kuisoon Kim of Pusan National University (Korea) for **Lewis Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 160*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7-3, 21000 Brookpark Rd., Cleveland, OH 44135. Refer to LEW-15260.

High-Frequency Analog CMOS Adaptive Filter Circuit

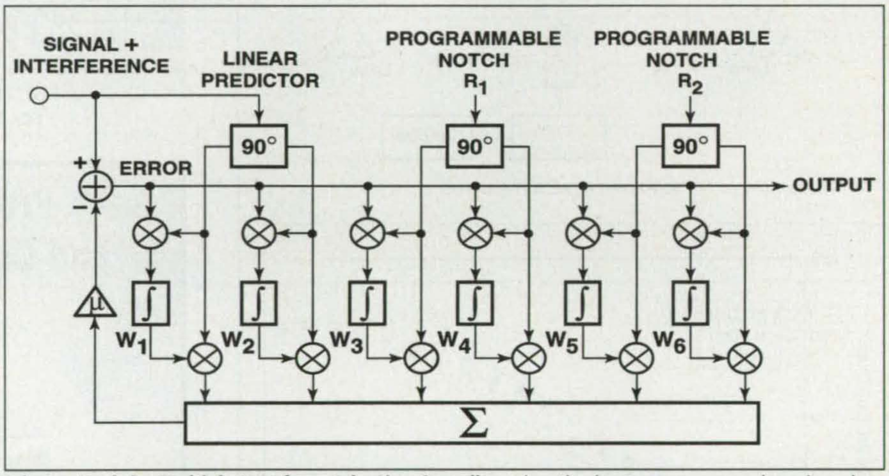
The circuit facilitates low-cost small interference cancellation and beam-forming for communications and radar systems.

Naval Research Laboratory, Washington, D.C.

An analog adaptive filter VLSI circuit using the least-mean-square-error algorithm realized in 2-micrometer CMOS technology with external feedback amplifiers has demonstrated operation up to 80 MHz in frequency, cancellation of two simultaneous interferences of up to 60 dB, a notch filter bandwidth as narrow as 20 kHz, and a minimum adapt time constant of 20 microseconds. According to the researchers the circuit's frequency of operation is the highest reported for an integrated-circuit analog adaptive processor of its type. The chief potential uses for the circuit are as a co-site interference canceller, a multiple programmable notch filter, or an adaptive array sidelobe canceller for communications or radar systems.

The 90° phase-shift blocks used in the adaptive filter circuit demonstrated were commercially available quadrature hybrid modules. However, RC networks capable of providing the necessary signals 90° out of phase have also been integrated in the same CMOS process used for the multiply-integrate-multiply circuitry. Continuous-time tapped delay lines (based on SAW, crystal, transmission-line, or integrated-circuit delay-line technology) could also be used along with the 90° blocks to improve performance for linear predictor or adaptive antenna array applications.

One of the serious difficulties in designing analog CMOS adaptive circuits is errors due to transistor threshold mismatches. This adaptive filter circuit contains a novel autozeroing circuit to greatly reduce the most significant error of this type: DC input offset voltages of the integrator and DC input and output offset voltages of the first multiplier in each tap. Another serious difficulty for which a novel solution has been invented is the problem of excess delay (or phase shift) in the high-speed feedback path.



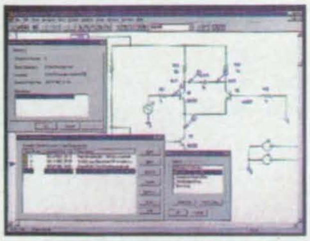
Schematic of the **Multiple Interferer Adaptive Canceller** using the least-mean-square learning algorithm. It can be configured as a multiple programmable notch filter, a co-site interference canceller, a linear predictor, or an adaptive array sidelobe canceller.

The adaptive filter circuit consists of a number of multiply-integrate-multiply taps (integrated in CMOS) whose outputs are summed and fed back (through off-chip feedback amplifiers). The difference between the feedback and input signals, the error signal, is used to update the weights, and also serves as the output signal. The first multiplier in each tap correlates the error with the reference signal for that tap, and the result is then integrated over time, continuously updating the weight for that tap. The second multipliers and summing block produces a weighted combination of the reference signals, which is then fed back. A pair of taps is required for cancelling a single jamming tone.

This work was done by Fritz Kub and Eric Justh of the **Naval Research Laboratory**. *A patent is pending. Inquiries concerning rights for the commercial use of this invention should be addressed to Dr. Richard H. Rein, Head, Technology Transfer Office of the Naval Research Laboratory, 4555 Overlook Ave. SW, Washington, D.C. 20375-5320; (202) 767-3744.*

NEW PRODUCTS

Product of the Month



Desktop Electronic Design & Analysis

MicroSim Corp., Irvine, CA, introduces Release 8, which it calls a tightly integrated start-to-finish desktop electronic design and analysis (EDA) system for mixed analog/digital designs. The company points to two new features as innovative: Design Journal™ and Design Manager. The first enables engineers to mark checkpoints at key crossroads, try alternative design directions, compare the results of all the alternative choices on a single graph, then proceed with the best option. Design Manager functions as an automatic organizer, linking together all files, even non-EDA documents and references to outside definitions, associated with the design into a single, self-contained entity. Symbols from Models, another key feature, allows engineers to download simulation models published by manufacturers on the Internet, and the system will create symbols for the models automatically in minutes.

For More Information Circle No. 793

Rotary Encoder with Digital/Analog Output

OakGrigsby, Sugar Grove, IL, introduces the 700 Series of mechanical encoder/potentiometers, a family it says is the industry's first to combine digital or analog circuitry, low cost, and the compact size of the 0.890-in. package. The line also features an integrated pushbutton option, available with or without detent in either output, for single-shaft/dual-function applications for either interface. The encoders can interface directly with digital circuitry without an A/D converter. The 700 Series has a 100,000-cycle life rating at normal operating current, requires no external power source, and can be installed directly on a PC board with a mounting bracket.

For More Information Circle No. 794

Micro AC for Small Enclosures

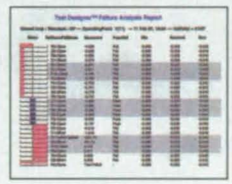
The design of the new line of micro air conditioners from Rittal, Springfield, OH, was done with space-saving in mind. The unit, which can be mounted on the wall or recessed through the wall of the enclosure, has a footprint of just 20 in. H X 10.6 in. W X 4.7 in. D. An abuse-resistant microprocessor controls and monitors enclosure temperature. A sealed barrier between external and internal air-flow paths provides NEMA 12 protection. The units, which use CFC- and HCFC-free refrigerant, can operate at up to 131°F ambient.

For More Information Circle No. 795

Bump Measurement Profiling System

The new noncontact 3D optical profiler from Wyko, Tucson, AZ, measures bump heights below 150μm for process control of flip-chip packaging. The system, which utilizes optical phase-shifting and vertical scanning interferometry, processes up to 30 million data points per second. Employing an Equipe Technologies robot and a wafer prealigner, the system measures wafers from 4-8 in. in diameter. In production, the profiler automatically detects bump position, solder bridges, and missing and extra solder bumps, displaying pass/fail results and position statistics at the bump, die, wafer, and lot levels.

For More Information Circle No. 796



Simulation-Based Test Software

Intusoft, San Pedro, CA, calls its Test Designer™ an EDA tool that automates analog and mixed signal fault simulation, fault diagnosis, test software development, and acceptance test generation. It includes a fully integrated schematic entry tool, extensive model libraries, a state-of-the-art SPICE3-based simulator, a graphical data postprocessor, and many features to handle test-data analysis and reporting. All key data entry, analysis, and reporting features are graphically driven. More than 10,000 part models are provided, and most include predefined failure modes.

For More Information Circle No. 797

Lithium-Ion Battery Protector

Unitrode Corp., Merrimack, NH, introduces a two-cell lithium-ion battery pack protector that incorporates an on-chip series field effect transistor (FET) switch. The UCC3911 safeguards applications against battery output short circuits. Its precision-bandgap voltage reference detects when either cell is in an overcharged or overdischarged state. The FET switch then opens, protecting the cells. Temperature range is -20°C to +70°C. It is available in a 16-pin SOIC package. Price of the UCC3911 is $3.40 in quantities of 1000.

For More Information Circle No. 798

MOSFET Relays for Many Applications

The new G3VM line of MOSFET relays from Omron Electronics, Schaumburg, IL, is available not only in standard 1 Form A 6-pin and 2 Form A 8-pin but also 4-pin configurations, and in industry-standard surface mount and through-hole mounting configurations. The devices also come in a variety of continuous-load current connections—AC, DC single and DC parallel—at 120, 150, and 200 mA. Omron suggests the relays for telecommunications hook signalling and line seize, datacom modems, and automatic test equipment. Pricing starts at $1.80 in quantities of 1000.

For More Information Circle No. 799

Digital Power Metering System

The Integra from the Crompton Instruments Group of BTR Instruments, Manchester, NH, is a panel-mounted digital instrument that measures and displays more than 100 electrical parameters. By simple keystrokes the user can check such parameters as V, A, Hz, W, VA, Var, kWh, kVA Demand, Min/Max, and more. The company says its true RMS measurement insures accurate readings of distorted waveforms, and that it offers excellent harmonics handling. It has three optional output modules: RS232/RS485 communications, pulsed output, and analog providing four 0-1 mA isolated outputs.

For More Information Circle No. 800

Signal Conditioning/ Isolating Blocks

The MSC OPEN Signal™ family of single-channel signal conditioning and isolating modules from SensorPulse Corp., S. Easton, MA, is field-configurable to meet the user's requirements, but can also be preconfigured or custom-configured at the factory for plug-and-play applications. Model types determine the input signal type—current, voltage, thermocouple, RTD, frequency, potentiometer—and the output type—current or voltage. The devices have full 16-bit resolution and a worst-case accuracy of 0.1 percent at the output signal range. The terminal block measures 85 X 50 X 11 mm and is DIN rail-mountable.

For More Information Circle No. 801

Surface-Mount or Through-Hole Inductors

Prem Magnetics Inc., McHenry, IL, introduces the SMI series of surface-mount or through-hole-mount inductors. They feature an above-board height of 0.340 in. maximum. A wide range of inductance values gives the user flexibility in meeting a variety of SMPS and RF applications. Prem says that the SMI series' open coil/core construction makes the inductors very economical. Pricing is in the $1-per-unit range in production quantities for both surface-mount and through-hole-mount styles.

For More Information Circle No. 802

Precision Differential Amplifiers

Preamble Instruments, Beaverton, OR, is expanding its 1800 series of precision differential amplifiers with the Model 1822, a stand-alone amplifier intended to act as a signal-conditioning preamplifier for oscilloscopes as well as network and spectrum analyzers. Used with the Model 1822, an oscilloscope's 1-mV-per-division sensitivity can be increased to 1μV per division. Gain can be set at 1, 10, 100, or 1000, and inputs can be attenuated by a factor of 10. Full bandwidth is DC-10 MHz. The Model 1822 has a built-in precision offset voltage generator that can be set to any voltage between +/-15.5 V.

For More Information Circle No. 803

Materials

Heteroepitaxial Growth of Monocrystalline Boron Nitride

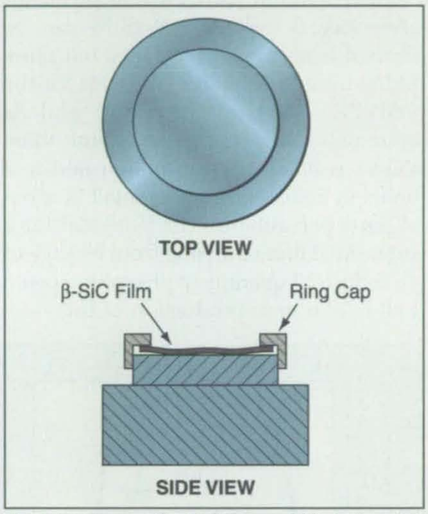
Thin films of β-SiC would be used as substrates for deposition of cBN.

NASA's Jet Propulsion Laboratory, Pasadena, California

In a proposed deposition process, monocrystalline cubic boron nitride (cBN) would be grown heteroepitaxially on silicon carbide films. Success in the development of the process would enable the growth of bulk cBN (perhaps also diamond) for making high-temperature, high-power, high-frequency electronic devices.

Heretofore, the growth of monocrystalline boron nitride heteroepitaxial layers has been impeded by the lack of a suitable substrate material; to obtain the monocrystalline form, one must use a substrate with a crystalline lattice that closely approximates that of cBN. When silicon and other substrate materials have been tried, the lattice mismatches have resulted in amorphous BN in some cases and polycrystalline BN in other cases.

The substrate material in the proposed process would be a film of β-SiC, 10 to 30 μm thick. The film would be formed on a substrate of single-crystal silicon, then removed from the silicon substrate and mounted in a graphite holder that would minimize bowing. The film, mounted in the holder, would be placed in an electron-cyclotron-resonance chemical-vapor-deposition chamber, where BN would be grown on the film. The lattice mismatch between the film would give rise to a compressive stress in the film, causing the film to bow slightly. The slight yielding of the film under the lattice-mismatch stress would reduce the lattice mismatch enough to allow the BN to grow in the desired cubic-lattice monocrystalline form.



The **Ring Cap on the Holder** would help to minimize bowing of the β-SiC film during chemical vapor deposition of BN.

This work was done by Virgil B. Shields and Frederick Pool of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 127*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
NPO-19761

Monolithic Foam Supports for Iridium Catalysts

Experiments indicate that monolithic catalysts can outperform granular catalysts.

Lyndon B. Johnson Space Center, Houston, Texas

Experiments have demonstrated the feasibility of catalytic beds in the form of iridium (the active catalytic material) supported by monolithic foams composed of noncatalytic materials. Heretofore, the state-of-the-art commercial iridium catalyst has consisted of iridium supported on alumina spheres.

The monolithic foams can be made of materials that withstand temperatures of 2,000 °C or more. In comparison with catalytic beds made of packed iridium-coated granules, the developmental foam-supported catalysts offer greater catalytic surface area with less weight, present less resistance to the flow of reactant gases, and do not degrade over time with regard to performance or flow resistance. In addition, the foam-supported catalysts can be made to exhibit lower thermal masses and lower thermal conductivities so that they absorb less heat from reactants. This is an important advantage if the application is as a catalytic igniter in a liquid-propellant rocket engine, with fuel/oxidizer reactant combinations such as hydrogen/oxygen (H_2/O_2) or monomethyl hydrazine/nitrogen tetroxide (MMH/NTO).

Some of the supporting materials under consideration are special high-surface-area carbon foams made, in part, by augmentation of precursor materials and subsequent processing to obtain the desired porosity. Iridium is then formed on the surfaces of the foam ligaments. Other promising foam materials include silicon carbide, silicon nitride, boron carbide, titanium boride, and hafnium carbide, although the experiments performed thus far indicate that carbon is the most effective foam material over a wide range of flow conditions (depending on the materials being catalyzed). Further development efforts are expected to focus on optimization of fabrication processes to maximize surface areas, levels of catalytic activity, operating temperatures, and life expectancies and to improve thermomechanical properties and environmental compatibility.

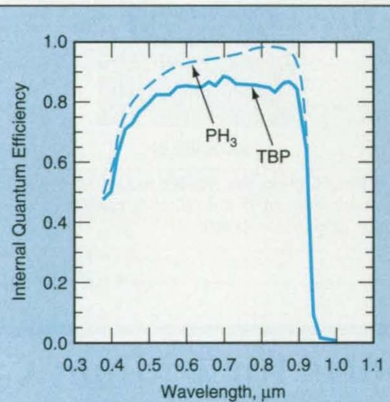
This work was done by Raffaele La Ferla, Qin Jang, Robert H. Tuffias, and Richard B. Kaplan of ULTRAMET for **Johnson Space Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 132*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
MSC-22287

Making InP Solar Cells From Tertiarybutylphosphine

The risk of exposure to toxic fumes is reduced substantially.

Lewis Research Center, Cleveland, Ohio

Experiments have shown that tertiarybutylphosphine (TBP) is suitable for replacing phosphine as a precursor chemical in the fabrication of indium phosphide-based solar photovoltaic cells. Heretofore, doped and undoped films of InP for solar cells have been grown by organometallic vapor-phase epitaxy (OMVPE), using phosphine (PH_3) and trimethylindium [$In(CH_3)_3$] as precursor chemicals. Excellent InP films can be formed from these precursors, but phosphine must be supplied in excess for the OMVPE chemical reactions and is extremely toxic; its threshold limit value (TLV) is 0.3 parts per million and it is lethal in concentrations as small as several parts per million. The potential for a substantial hazard arising from leakage of an industrial quantity of phosphine could well inhibit mass production of InP.



	TBP	PH_3
FF%	82.6	82.4
V_{OC} (mV)	871	876
J_{SC} (mA/cm²)	30.7	36.3
p+ Buffer	No	Yes
Dual Layer ARC	No	Yes

Internal Quantum Efficiency was among the parameters measured in tests of cells made with TBP and compared with values from cells made with PH_3. The slight deficit of the TBP cell with respect to the PH_3 cell in this example is attributed to defects that were present in the substrate of the TBP cell prior to epitaxial deposition of InP from TBP. Presumably, such defects could be eliminated in future units.

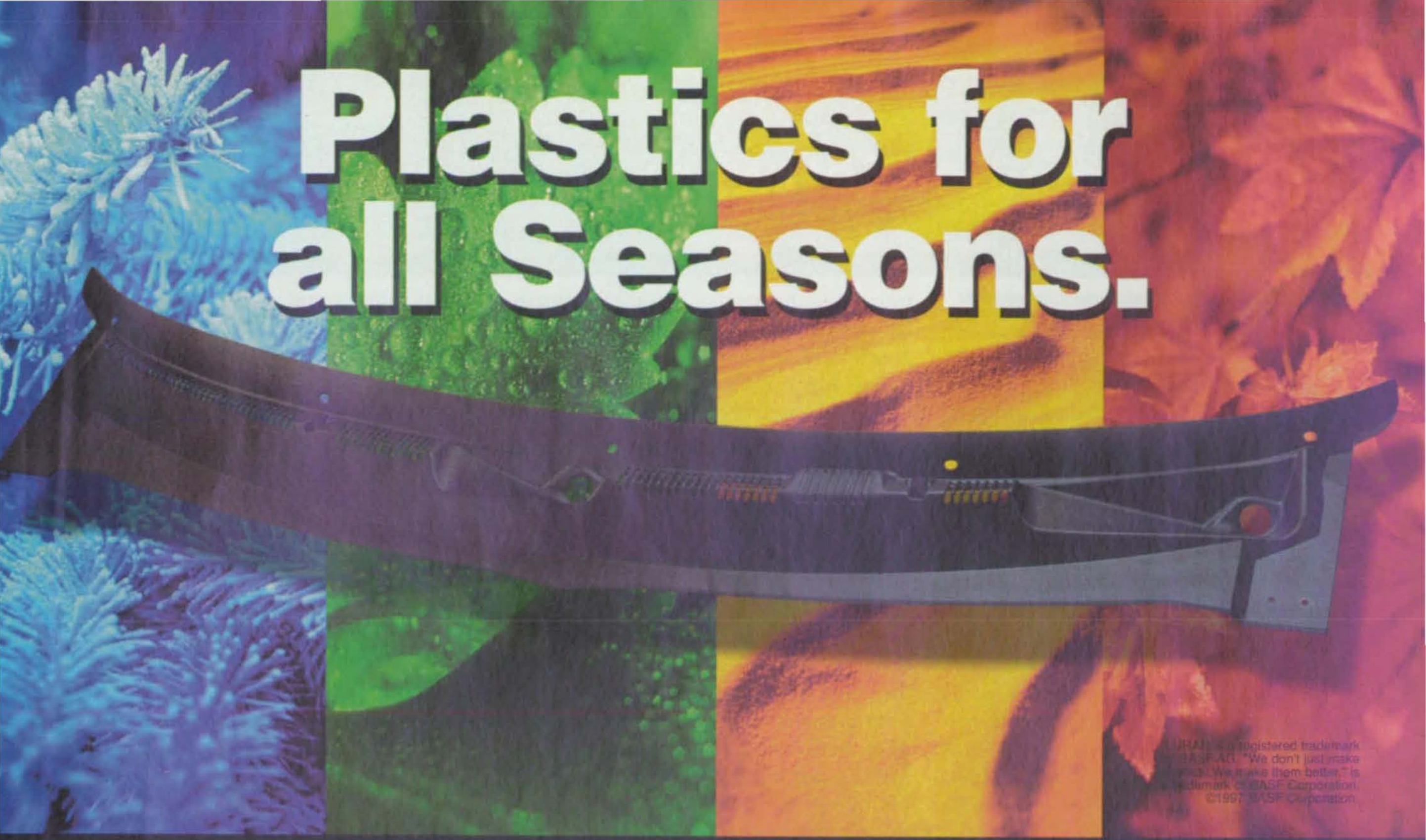
TBP was selected as a candidate to replace phosphine because it is much less toxic (TLV 1,100 parts per million). TBP is supplied as a liquid, the vapor pressure of which is suitable for introduction into an OMVPE reactor. TBP costs more than phosphine does, but the greater cost of TBP would be offset by the reduction of risk and simplification of treatment of effluent from the OMVPE process. Prior to these experiments, excellent InP films for microwave semiconductors had been grown with TBP at concentrations smaller than the corresponding concentrations of phosphine, and at temperatures lower than those used for phosphine. However, prior to these experiments, InP films with areas large enough and minority-carrier lifetimes long enough for efficient solar cells had not been grown from TBP.

In the experiments, doped and undoped InP films were deposited from TBP and $In(CH_3)_3$ precursors injected into a flow of purified hydrogen, which served as a carrier gas. The gas pressure in the reactor was typically 150 torr (20 kPa). The deposition substrate was heated to a temperature of 590 °C. Acceptor (p) doping was achieved by injection of diethyl zinc into the flow of H_2; donor (n) doping was achieved similarly, using silane as the precursor. Some of the films were used to fabricate solar cells, which were then tested. The tests showed that in most respects, the cells made with TBP performed comparably (see figure) to state-of-the-art cells made with phosphine.

In the table, the measured solar-cell performance parameters of open circuit voltage V_{OC}, short-circuit current density J_{SC}, and fill factor FF for the TBP cell are compared to performance data from the world record PH_3-produced InP solar cell. The only shortfall of the TBP cell is in J_{SC}, which can be improved to comparable levels by minor adjustments to the device structure. The internal quantum-efficiency data only show the short-circuit current deficiency of the TBP cell compared to the PH_3 cell.

This work was done by David M. Wilt, David J. Brinker, and William E. Frey of **Lewis Research Center**, *Richard W. Hoffman, Jr., of Analex Corp., and Navid S. Fatemi, Phillip P. Jenkins, and David A. Scheiman of NYMA, Inc. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 129*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7-3, 21000 Brookpark Rd., Cleveland, OH 44135. Refer to LEW-16314.


Plastics for all Seasons.

Computer Software

Software for Efficient Dynamic Management of Memory Space

The Personal Space Management (PSM) computer program is a library of subprograms that provide functions to support efficient, dynamic partitioning of a contiguous block of random-access memory to suit an application program or programs. PSM minimizes processing overhead incurred in the management of memory space, minimizes waste of memory space, and prevents one application from using all memory space and thereby causing other applications to fail. PSM divides each partition of memory space into two "pools" of variable size; a "small" pool of low-overhead blocks containing as many as 256 bytes of user data apiece, and a "large" pool of high-overhead blocks that contain as many as 2GB of user data. The "small" pool provides extremely rapid management of the blocks within it, while the "large" pool manages its blocks somewhat less rapidly but makes a greater effort to minimize waste of space. PSM runs under either VxWorks or SunOS 4.1.3 on a variety of computers.

This program was written by Scott Burleigh of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no.120*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-19903.

Software Restores Image Blurred By Spatially Variable PSF

The Massively Parallel Richardson-Lucy (MPRL) computer program implements the Richardson-Lucy algorithm, which deconvolves an image from a spatially variant point-spread function (SV-PSF). MPRL was developed to restore blurred images produced by the Hubble Space Telescope, but is also applicable to other optical systems in which images are sensed by charge-coupled devices or other arrays of discrete photodetectors. Because deconvolution is computationally intensive and SV-PSF deconvolution more so, the use of parallel (concurrent) processing techniques greatly accelerates the code throughput. This entails much more computation than is needed for deconvolution with a spatially invariant PSF in the Fourier domain, making it desirable to accelerate the computation by use of parallel (concurrent) processing. In the Richardson-Lucy algorithm, concurrency is achieved by systematic division of the image to be restored. Only pixel values within the support of the PSF are interdependent; thus, an arbitrary division of the image into segments with appropriate overlapping guard bands enables the independent processing of each segment. In MPRL, such concurrency is realized by use of a public-domain library known as the Parallel Virtual Machine (PVM) communications package. PVM makes it possible to implement a Richardson-Lucy restoration engine and to spawn a large number of such engines, each restoring different sections of the image, on a heterogeneous set of UNIX workstations. MPRL is also portable to such computers as the Intel Paragon and the Cray T3D.

This program was written by Andrew F. Boden of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 135*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
NPO-19914

Program Generates Point-Spread Functions

The Simulated Hubble Space Telescope (SHST) computer program generates point-spread functions (PSFs) to simulate the blurred images of stars and other point objects as they would appear in the Wide Field Planetary Camera II of the Hubble Space Telescope. The PSFs capture the imaging effects of diffraction and of imperfections in the telescope, camera optics, and camera photodetectors. SHST comprises an application program and sets of data, which include the prescription of the telescope, maps of imperfections of the telescope mirrors, and data on filters and other optical components. The application program uses the prescription and other data to trace a large grid of rays through the telescope and camera optics. The rays determine phases and vignetting for physical-optics calculations of diffracted images at the photodetectors. The images are resampled to the specified pixel size. This process is repeated for each spectral line to build up a particular PSF. The PSFs generated by SHST can be used in image-restoration programs — for example, the MPRL program described in the preceding article. SHST runs on UNIX workstations like the Sun SPARC and DEC Alpha computers. The prescription files in SHST are compatible with the commercial MACOS optical-analysis application program, which was developed in part by NASA's Jet Propulsion Laboratory.

This program was written by David Redding of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 156*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
NPO-19937

COSMIC, NASA's Software Technology Transfer Center, has an inventory of over 800 software packages that originally were developed by NASA and its contractors for the U.S. space program. These packages have a wide range of applications other than space exploration and are used by industry, academic institutions, and other government agencies.

For further information about software available from COSMIC, or to receive a free diskette catalog, contact COSMIC at:

COSMIC
The University of Georgia
382 East Broad Street
Athens, GA 30602-4272

Phone: 706-542-3265
Fax: 706-542-4807
e-mail:
service@cosmic.uga.edu
WWW:
http://www.cosmic.uga.edu

Constructing Finite Elements for the Integrated Force Method

These finite elements help to realize the potential of the integrated force method.

Lewis Research Center, Cleveland, Ohio

A method of constructing finite elements for use in two- and three-dimensional structural analysis by the integrated force method has been devised. In the integrated force method, all independent forces are treated as unknown variables that can be calculated on the basis of simultaneous imposition of equations of equilibrium and conditions of compatibility. Developed in recent years, the integrated force method offers advantages of greater accuracy and computational efficiency, relative to the standard displacement method.

The two-dimensional finite elements that can be constructed by the present method are triangular and quadrilateral elements (see Figure 1) that can be used in modeling arbitrary configurations. The three-dimensional finite elements that can be constructed by this method include tetrahedrons and hexahedrons analogous to the triangular and quadrilateral two-dimensional elements, plus tetrahedron- and hexahedron-like volumes with curved edges (see Figure 2).

The mathematical derivation for two dimensions begins with the construction of equilibrium and flexibility matrices for the elements from discretized equations for potential and complementary energies, respectively. The displacement and stress fields within the finite elements are independently approximated. The displacement field is interpolated in the same way as in the standard displacement method.

The stress field is approximated by complete polynomials of the correct order. The coefficients of these polynomials are initially unknown independent forces. The equations that describe the components of the stress tensor can be derived from the Airy stress function for an element, which is written in terms of a complete polynomial of a certain order. The resulting stress field identically satisfies the equations of equilibrium. The element matrices generated by use of this stress field are not sensitive to the orientation of the local coordinate system of the element.

The method includes a way of calculating the number of zero-energy (rigid-body) modes. It turns out that spurious zero-energy modes can be eliminated by constructing the stress field such that for each element, $n_r \geq n_e - 1$, where n_r is the rank of the equilibrium matrix of the element and n_e is the number of kinematic degrees of freedom of the element.

The mathematical derivation for three dimensions resembles that for two dimensions in some respects. It begins with a general formulation to generate a stress-interpolation matrix for each finite volume element terms of complete polynomials of the required order. The formulation is based on definitions of components of the stress tensor in terms of stress functions. The stress functions are expressed as complete polynomials and substituted into equations for stress components. Then elimination of linearly dependent coefficients leaves the stress components expressed as complete polynomials, the coefficients of which are defined as generalized independent forces. The components of the stress tensor thus derived identically satisfy the homogenous Navier equations of equilibrium. The resulting element matrices are invariant with respect to coordinate transformations and are free of spurious rigid-body modes.

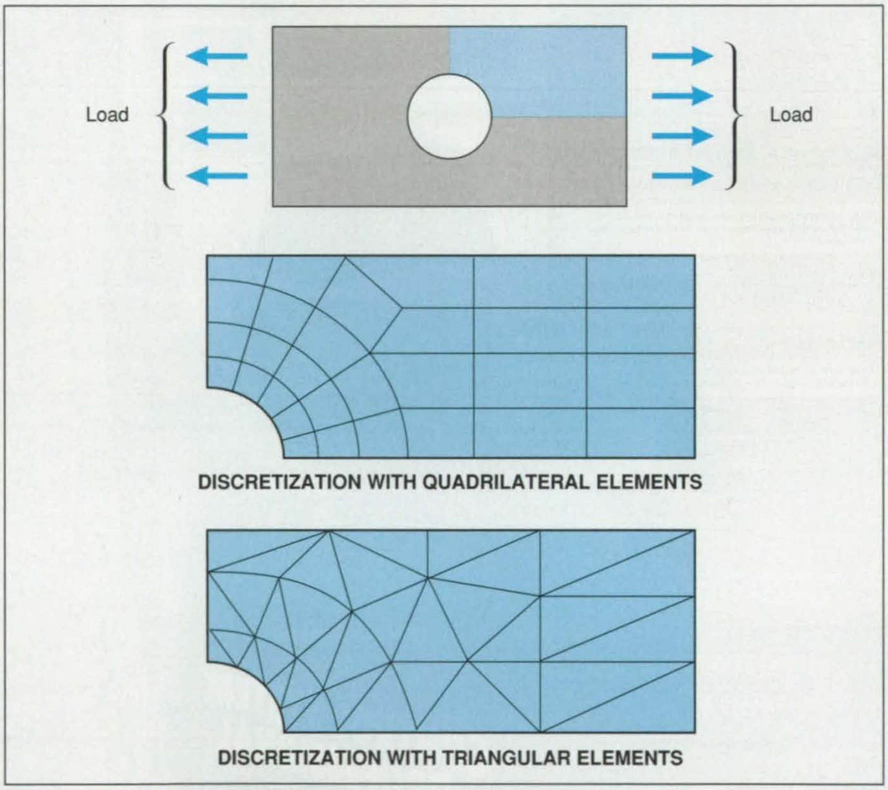
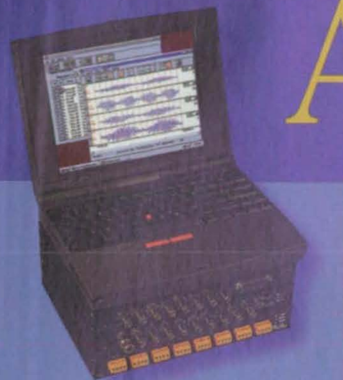


Figure 1. A **Rectangular Plate With a Round Hole** in uniform tension is one of many structural-analysis problems that can be solved by the integrated force method, using triangular or quadrilateral finite elements generated by the method described in the text.

The formulation provides a rational way to calculate the exact number of independent forces necessary to arrive at a complete-polynomial approximation of the required order. Unfortunately, interpolation of stress with complete polynomials can necessitate

Out-of-the-Box™ Portable Data Acquisition

FREE Signal Conditioning Handbook! (see below)



Expandable systems up to 256 channels

1-MHz parallel-port-based systems for high-speed applications

PCMCIA cards for ultra-compact solutions

Signal conditioning for a wide range of sensor and signal types

IOtech *invented* portable PC-based data acquisition—and we continue to lead with the most comprehensive offering of software and hardware for notebook *and* desktop PCs.

Software

Our data acquisition systems include *Out-of-the-Box*™ DaqView or WaveView software for *instant* signal verification, acquisition, real-time display, storage to disk, plus direct export to Excel™. No programming or training courses are necessary, and FREE technical support is available for as long as you own your system.

If you prefer to develop your own application, we offer DASYLab™, a comprehensive yet easy-to-use, icon-based environment with real-time display, analysis, and custom graphical user-interface capabilities. We also provide FREE drivers for Windows 3.1™, 95™, and NT™, and LabVIEW™, Snap-Master™, and LABTECH NOTEBOOK™.

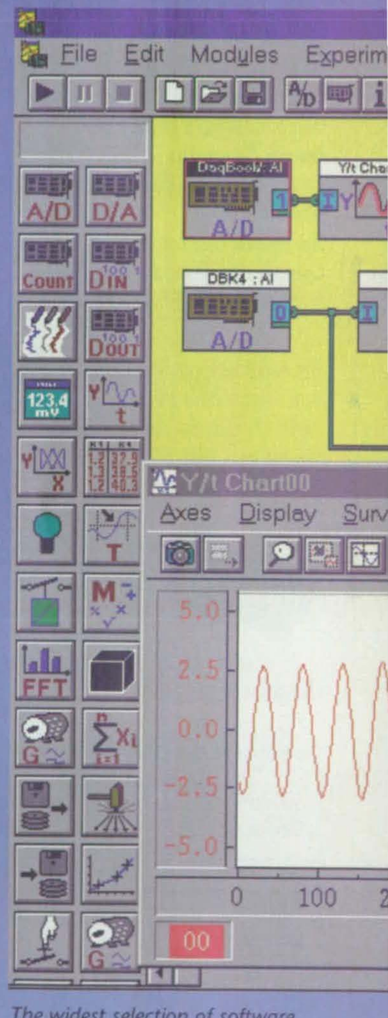
Hardware

IOtech offers the industry's widest selection of portable data acquisition hardware, with over 80 components to choose from. Our PCMCIA and parallel port-based A/Ds offer 100-kHz to 1-MHz sampling, 12- and 16- bit resolution, and up to 256 channels. We also offer signal conditioning and expansion options for thermocouples, RTDs, strain gages, accelerometers, 4-20 mA, isolation, frequency, digital I/O, pulse inputs, and much more.

All IOtech A/Ds and options work together with our software to maintain high-speed sampling, even if your system has multiple sensor types. Plus, your readings are automatically converted to engineering units, so there is no need to fumble with linearization or compensation algorithms.

For more information on our *Out-of-the-Box*™ solutions for portable data acquisition, call us toll-free at 1-888-724-8390 or e-mail us at sales@iotech.com.

Circle 635



The widest selection of software support in the industry

(* For users who prefer to program, we also provide free drivers for LabVIEW®, Visual Basic™, C™, & Pascal®; DASYLab™, Snap-Master™, & LABTECH NOTEBOOK™ drivers are also available).

IOTECH WORLDWIDE SALES OFFICES:

Australia +61 3.9569.1366; **Austria** 43 (316) 30700; **Belgium** +32 2 466 81 99; **Canada** Montreal (514) 697-3333, Ottawa (613) 596-9300, Toronto (905) 890-2010, Vancouver (604) 988-2195; **China** +86 (10) 6232-9880; **Denmark** +45 45 82 7878; **Eastern Europe** +43 1.54.515.88; **Finland** +358 9.476 1600; **France** +33 1.34.89.78.78; **Germany** +49 711 9-02-97-0; **Hong Kong** (+852) 2875-1830; **India** +91 80 6655333; **Israel** +972 3 649 8538; **Italy** +39 2 392 66561; **Japan** +81 3-5688-6800; **Korea** +82 2 538-4001; **Netherlands** +31 79 360-00-18; **New Zealand** +64 9309 2464; **Singapore** +65 482-5600; **South Africa** +27 (12) 660-2884; **Spain** +34 1.570 2737; **Sweden** +46 13-31 0140; **Switzerland** +41 1.825.57.77; **Taiwan** +886 2.5017065; **United Kingdom** +44 (1296) 397676

IOtech®

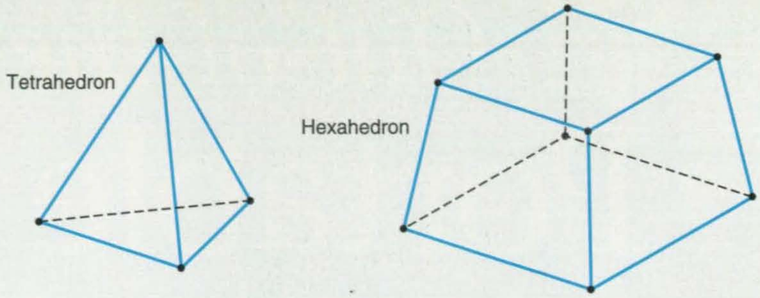
the smart approach to instrumentation™

Toll-Free 1-888-724-8390

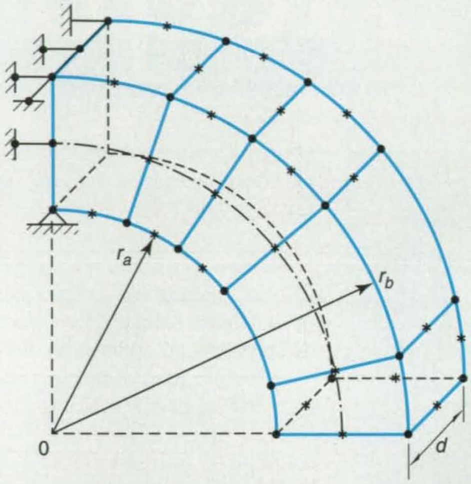
Contact us today for your FREE Signal Conditioning Handbook, 1997 Catalog, & demo CD!

CE ISO 9001

25971 Cannon Road ■ Cleveland, OH 44146 ■ 216 439-4091 ■ Fax: 216 439-4093 ■ http://www.iotech.com ■ sales@iotech.com



TYPICAL FINITE VOLUME ELEMENTS



CIRCULAR ARCH MODELED WITH HEXAHEDRONLIKE CYLINDRICAL FINITE VOLUME ELEMENTS

Figure 2. **Tetrahedral, Hexahedral, and Similar Elements** can be used to model bodies with arbitrary shapes. For example, a circular arch can be modeled by concatenated hexahedron-like cylindrical volume elements of axial length d, inner radius r_a, and outer radius r_b.

the use of a large number of independent forces for each element, in some cases leading to inconveniently large final systems of equations. Therefore, it could be worthwhile to attempt to reduce the number of independent forces in stress-interpolation polynomials while preserving the accuracy and reliability of the resulting finite elements. However, one should proceed with caution because at present, there is no rational procedure for uniquely deriving stress fields with minimum numbers of independent forces, there is no proof that the resulting elements are free of spurious zero-energy modes, and in some problems, the elements can fail unexpectedly.

The present method has been tested on two- and three-dimensional example stress-analysis problems for which exact solutions are available. In the tests, the problems were solved by (1) the integrated force method using finite elements generated by the present method and (2) the standard displacement finite-element method. In the two-dimensional tests, it was found that overall, the integrated force method using finite elements generated by the present method performed better than did the standard displacement method in predicting stresses, and that the integrated force and displacement methods performed comparably in predicting displacements. In the three-dimensional tests, it was found that typically, the integrated force method using finite volume elements generated by the present method performed about as well as or better than did the standard displacement method in predicting stresses.

This work was done by Dale A. Hopkins of **Lewis Research Center** *and Igor Kaljević and Surya N. Patnaik of Ohio Aerospace Institute. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category,* ***or circle no. 140*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16421.


Kid's stuff.
SOLID EDGE
MICROSTATION
SOLID WO
ARTIS
AL DESKTOP
Our stuff.
digital™
The Hardware.
Digital, the world's leading supplier of high performance Windows NT personal workstations, offers a family of Intel and Alpha platforms
– which make all other solutions look like child's play.
– which will run PT/Products at blazing speeds without busting your drawing allowance.
A Powerful Team.
Digital, in combination with PT/Products Authorized Resellers, is offering special incentives on both Intel and Alpha-based Windows personal workstations for maximum performance.
Call 1-800-DIGITAL for full details. Ask to speak to a workstation specialist and refer to code "QKP".
Which would you rather design with?
The PT/Products™ family includes a fully associative suite of mechanical design and manufacturing applications. The core module, PT/Modeler™, is a robust, 3D, parametric, feature-based, solid modeling system for part and assembly design, detailing, and documentation. Based on the proven technology of Pro/ENGINEER®, the PT/Products family is production-ready and dependable software ideally suited for manufacturing companies making the transition from 2D CAD systems to solid modeling. The U.S. list price for PT/Modeler is only $2995. Why pay more and get less?
Visit us today at http://www.ptproducts.com
and http://www.workstation.digital.com
PT/Products™ and PT/Modeler™ are trademarks of Parametric Technology Corporation.
All other company and product names are trademarks or registered trademarks of their respective owners.
For More Information Circle No. 575

First Supersonic Yaw-Vectoring Flight for the ACTIVE Program

Yaw is controlled via thrust vectoring.

Dryden Flight Research Center, Edwards, California

The F-15 Advanced Control Technology for Integrated Vehicles (ACTIVE) aircraft recently engaged in its first supersonic yaw-vectoring flight at Dryden Flight Research Center. ACTIVE is a joint program of NASA, the U.S. Air Force, McDonnell Douglas Aerospace, and Pratt & Whitney. The ACTIVE team will expand the flight envelope of the aircraft engine nozzles to mach 2 and 750 KCAS (knots calibrated airspeed) with maximum vector angles, rates, and power settings. In addition, the team will assess performance benefits and identify aerodynamic effects induced by two vectored supersonic jet exhausts. Current plans call for approximately 60 flights with a total time of 100 hours.

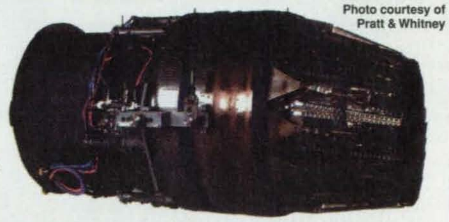
The F-15 research aircraft used in the ACTIVE program (see figure) is a one-of-a-kind system. For the first yaw-vectoring flight, power to reach supersonic speeds was provided by two state-of-the-art F100-PW-229 engines modified by installation of a pair of pitch/yaw balance beam nozzles (P/YBBNs), which are multidirectional thrust-vectoring nozzles that were used to vector the engine thrust horizontally and vertically during the flight.

For NASA's flight research, each P/YBBN was mounted on one of the two engines. The fan-duct cases of the engines were modified to provide the additional strength needed to withstand the vectoring forces. Installation of the P/YBBNs also necessitated minor modifications of the rear fuselage and main engine mounts. The P/YBBNs are symmetrical and can direct thrust at an angle up to 20° with respect to the engine centerline. The balanced-beam concept, which has been proven in service in F100 convergent/divergent exhaust nozzles, minimizes control actuation loads and reduces the need for heavy, reinforced structures.

Each P/YBBN nozzle includes a fail-safe dual redundant actuation system, making it compatible with single-engine as well as twin-engine aircraft. The PW-229 engine with a similar pitch/yaw-vectoring nozzle has been selected for integration into a modified F-16D aircraft in the U.S. Air Force's Variable-Stability In-flight Simulator Test Aircraft (VISTA) program. Moreover, the P/YBBN has been selected for the concept demonstrator Joint Strike Fighter competition aircraft.

F-15 RESEARCH AIRCRAFT

- Fail-safe design accommodates flight condition: nozzle remains open in supersonic flight, closes once flight becomes subsonic.
- Pin joints (no roller tracks or sliders) maximize resistance to wear.
- Divergent design enables independant exhaust-area control with optimal scheduling for performance and acoustics.



ENGINE WITH THRUST-VECTORING NOZZLE

The **ACTIVE F-15 Aircraft** features two state-of-the-art engines modified to include multidirectional thrust-vectoring nozzles.

Benefits expected to accrue from thrust vectoring in future aircraft include extended range, increased maneuverability, reduced operating cost, and greater safety. The present thrust-vectoring concept should lead to significant increases in performance of both civil and military aircraft flying at subsonic and supersonic speeds. Another important feature is the production-oriented P/YBBN design, which will ease transition of vectoring technology to production applications.

This work was done by Gerard Schkolnik, Tim Conners, John Orme, Bob Sims, Mike Earls, Kevin Kellenberger, John Carter, Mark Stephenson, Ting Tseng, and Karla Shy of **Dryden Flight Research Center**, *Jim Disbrow, Wes Ryan, and Mike Muratore of Analytical Services & Materials, Pete Schaefer of Sparta, and Michael Hufano, Don Warren, and John Flynn of McDonnell Douglas Aerospace. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category,* ***or circle no. 105*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge)*
DRC-96006

Manufacturing/Fabrication

Au X-Ray Grids on Si by Optical Lithography and Etching

These grids can be used in an x-ray solar telescope.

NASA's Jet Propulsion Laboratory, Pasadena, California

Fine-pitch, thin gold grids supported by silicon substrates have been developed for use in pairs to collimate x rays in imaging and spectroscopic instruments. These grids are designed to provide collimation at photon energies up to 30 keV. A representative grid of this type (see figure) comprises gold x-ray-absorbing slats 25 μm thick and 17 μm wide, with a pitch of 34 μm (so that the slats and the slits between them are of equal width). The grid also includes integral stiffeners perpendicular to the slats, with a pitch of 500 μm. The grid occupies an area 5.5 cm in diameter on the silicon substrate, which is a 200-μm-thick wafer of 3-in. (7.62-cm) diameter.

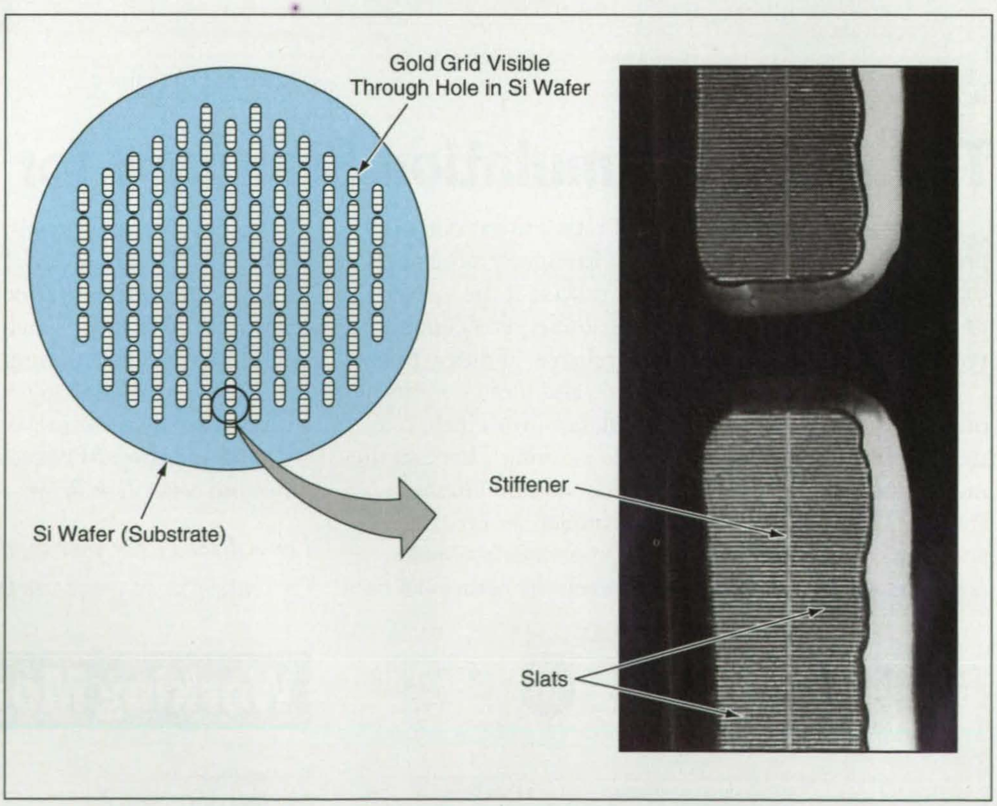
The silicon substrate is semitransparent at photon energies >10 keV, but blocks x rays with photon energies as low as 2 keV. To prevent the substrate from blocking the passage of low-energy x rays and to enable optical characterization of the grid, the silicon substrate is perforated with holes 1 mm wide by 4 mm long with rounded ends. These holes are arranged in staggered rows with their long axes perpendicular to the slits and slats.

Fabrication of the grid begins with evaporative deposition of a 50-Å-thick layer of Cr followed by a 300-Å-thick layer of Au on one side of the substrate to form a seed coat ("strike") for subsequent electroplating of the 25-μm-thick layer from which the grid will be made. A photoresist 25 μm thick is deposited on the strike, exposed in the grid-and-stiffener pattern, and developed. An oxygen plasma is used to strip resist residue from the strike. Then gold is electrodeposited onto the exposed parts of the strike between the remaining photoresist ridges to a thickness of 25 μm, forming a gold grid with photoresist between the slats.

The wafer is turned over and a 50-μm dry resist is applied and exposed in the pattern of the holes to be formed through the substrate. Using equipment at UC Los Angeles, the exposed parts of the substrate are etched through the entire thickness of the substrate by use of XeF_2 gas, which reacts with silicon to generate gaseous products that are carried away by a vacuum pump. The remaining parts of both photoresists are then removed by use of acetone followed by a "piranha" bath (5:1 H_2SO_4:H_2O_2). The Cr/Au strike in the holes through the substrate is removed by use of a solution of 3:1 HCl:H_2O_2, which etches Cr much more rapidly than it etches Au. Finally, a ring made of a low-thermal-expansion nickel/iron alloy (Invar or equivalent) is glued to the wafer.

Prototype grids fabricated in this way have been characterized by use of a visible-light calibration system to verify the registration of the grids. The grids were found to satisfy the registration specifications to the limit of the calibration system. The gold grids have been shown to be usable for the collimation purpose for which they were designed and can be easily tested by laser techniques while they are mounted in place in scientific instruments.

This work was done by Reid A. Brennen, Dean V. Wiberg, and Michael H. Hecht of Caltech and David Pankow of The Space Sciences Laboratory, UC Berkeley, for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing/Fabrication category,* ***or circle no. 172*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
NPO-19857



A **Thin Gold Grid** is supported on one face of a silicon wafer that contains holes in staggered rows. The holes allow lower-energy x rays to pass through the wafer to the grid, and enable optical inspection of the grid.

Collimating Cylindrical Microlens Assembly for Diode-Laser Arrays

Lasers are used to define lens axes via photolithography.

Goddard Space Flight Center, Greenbelt, Maryland

A method of fabrication of cylindrical microlenses in precise alignment with two-dimensional arrays of diode lasers has been invented. The method is applicable to arrays in which the light-emitting facets of the individual lasers are typically about 10 µm wide and 1 µm high. These are etched in a semiconductor chip, which is cut into 1-cm wide chips, or bars, for mounting in two-dimensional stacks, as shown in Figure 1. The interbar spacing is typically 400 µm, which is the minimum spacing in which the heat can be removed effectively from each chip. These packages are assembled and soldered manually, thus the interbar spacing can vary by ± 40 µm. The light emitted from these facets is highly divergent in the cross-sectional plane perpendicular to the rows, due to diffractive effects of the 1-µm aperture. Precisely aligned cylindrical lenses are needed to collimate each 1-cm row of beams for efficient coupling to external devices; for example, coupling pump light into solid-state laser crystals. The assembly of cylindrical lenses for a two-dimensional stack of arrays is very difficult, as each lens placement requires micron accuracy.

The essence of the method is to use the pattern of light emitted by a diode-laser array as the master pattern to define a pattern of cylindrical lens placement on a rack that can later be registered mechanically with the array. First, a sheet or plate of photolithographic film is placed on a translational stage, parallel to

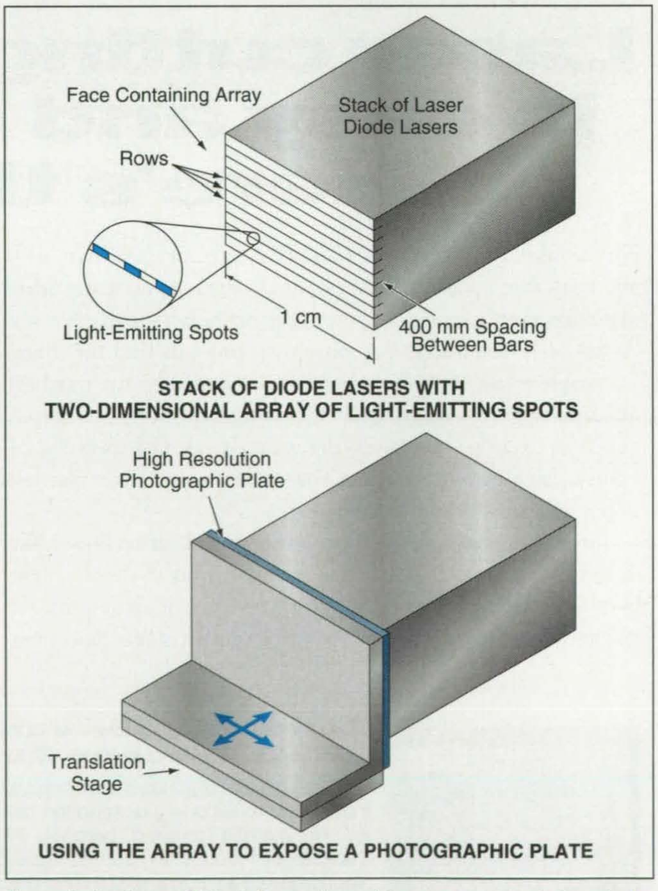


Figure 1. An **Array of Diode Lasers** is used to expose a translating photographic plate, forming streak images coincident with its rows.

the face of the array. The plate is placed in contact with the diode array. (This does not damage the semiconductor material, as each chip is mounted on individual heat-sink shims, recessed by around 40 µm from the front of the array package.) The array is turned on to expose the plate, making a 1:1 image of the individual rows of diode lasers. The photographic film is then gently pulled away from the array and translated a few millimeters to the left or right and reset in contact with the array where another laser pulse is exposed on the film. When performed correctly and with the correct intensity, a 12- to 14-mm wide image is formed from which a chrome-on-glass photomask can be made for photolithography. Of course, all the handling of the film and the exposing process must be performed in darkness. To reduce the difficulty of making exposures, a laser "camera" has been constructed that allows the complete alignment and setting up of the laser array and film to be done in low light. All that is left for the darkness is the removal of the exposure plate and the adjustment of the laser array to contact the film.

The photomask is used for the standard photolithographic process where a silicon wafer is etched with troughs, corresponding with the exact arrangement of the particular diode array. The trough aspect ratio and wall slope angle are determined by (1) the photoresist ultraviolet exposure and etching times and (2) the orientation of the silicon crystal lattice in the wafer, respectively. A central section of the etched image, corresponding to the emitting face dimensions of the diode-array package, is cut from the silicon wafer. What remains is a rectangular hole with etched troughs, a few millimeters wide, on opposing sides of the hole. It is in these troughs that the ends of tiny cylindrical lenses will be precision glued into place, such that the lenses will span the hole and be identically spaced with each other as the individual bars in the laser-diode array. The cylindrical lenses are silica rods, 100 to 300 µm in thickness, and are drawn into shape like fiber optics. Through this process, an ashperical shape can be produced on the front and the back of the lens, thus creating an excellent single-element optic (see Figure 2).

This work was done by D. Barry Coyle of **Goddard Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing/ Fabrication category,* ***or circle no. 122*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patient Counsel, Goddard Space Flight Center; (301) 286-7351. Refer to GSC-13635.

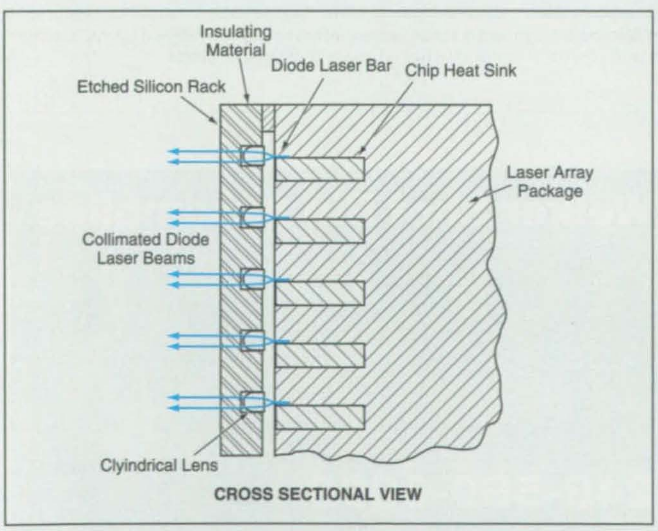


Figure 2 A Fully **Assembled Lens Rack and a Diode Array** are shown here. Strips or a layer of insulating material (e.g., tape), or high-temperature epoxy can be applied to the remaining flat face of the plate to set the lens-to-laser distance accurately for collimation.

Life Sciences

Microwave Treatment of Cardiac Arrhythmias

A catheter contains a coaxial cable that delivers microwave energy via a small antenna.

Lyndon B. Johnson Space Center, Houston, Texas

An experimental method of treating tachycardia involves the microwave-induced ablation of a 10-mm layer of arrhythmogenic muscle tissue at the affected inner surface of the heart. In this method, the affected tissue is heated by microwave energy applied via a catheter. A thin coaxial cable in the catheter delivers the microwave energy to the tip of the catheter. A small antenna at the tip is designed for optimal coupling of the microwave energy from the coaxial cable into the tissue. The absorption of microwave energy in the tissue causes heating, which, in turn, produces the desired lesion.

The microwave frequency must be chosen so that the microwave energy is absorbed predominantly in a surface layer of the desired thickness: if the frequency is too low, the microwaves propagate too far through the tissue, producing heating that is too diffuse; if the frequency is too high, the energy is dissipated in too thin a layer near the surface. The optimum frequency is expected to lie in the range of 4 to 6 GHz, the exact value depending on the electrical conductivities and permittivities of blood and heart muscle (see Figure 1).

In comparison with other methods that involve direct-current pulses or radio frequencies below 1 GHz, this method may prove more effective in treating ventricular tachycardia. This is because the present method provides for greater control of the location, cross-sectional area, and depth of a lesion via selection of the location and design of the antenna and the choice of microwave power and frequency. An apparatus has been constructed to test the concept in experi-

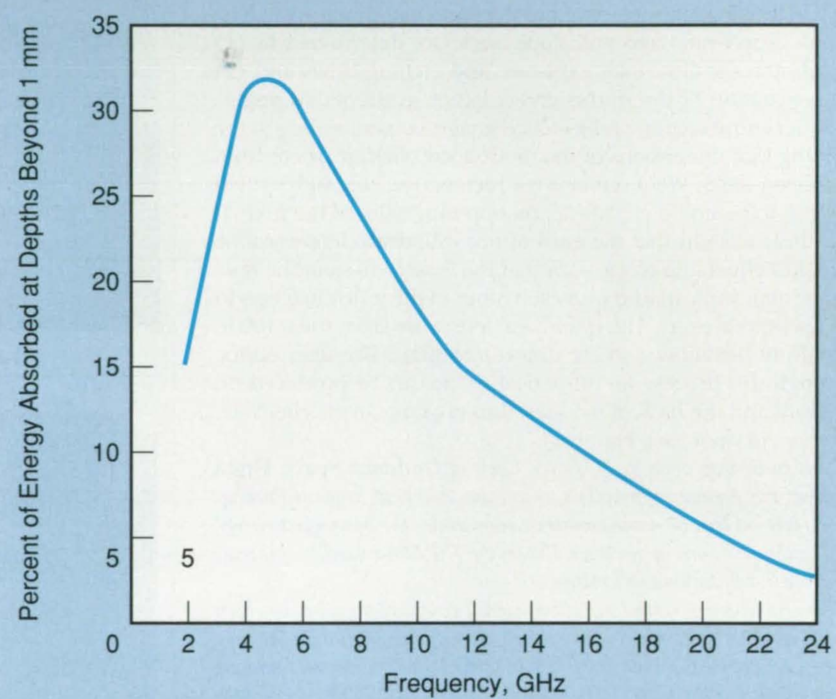


Figure 1. **Heating Effects of Microwaves** in heart tissue were mathematically modeled, using assumed values of the permittivities and electrical conductivities of heart muscle and blood.

Vol. 21, No. 7 July 1997 This card expires: Dec. 31, 1997

Fast Fax Information Form

Use this form for quickest processing of your inquiry, or if the bind-in card has been removed. Fax: (413) 637-4343.

Name ______________________________

Company ______________________________

Address ______________________________

City/St/Zip ______________________________

Phone ______________________________ Fax ______________________________

e-mail ______________________________

Circle the numbers below to order Technical Support Packages for briefs in this issue.

101	102	103	104	105	106	107	108	109	110	111	112	113	114
115	116	117	118	119	120	121	122	123	124	125	126	127	128
129	130	131	132	133	134	135	136	137	138	139	140	141	142
143	144	145	146	147	148	149	150	151	152	153	154	155	156
157	158	159	160	161	162	163	164	165	166	167	168	169	170
171	172	173	174	175	176	177	178	179	180	181	182	183	184
185	186	187	188	189	190	191	192	193	194	195	196	197	198
199	200	201	202	203	204	205	206	207	208	209	210	211	212
213	214	215	216	217	218	219	220	221	222	223	224	225	226
227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254
255	256	257	258	259	260	261	262	263	264	265	266	267	268
269	270	271	272	273	274	275	276	277	278	279	280	281	282
283	284	285	286	287	288	289	290	291	292	293	294	295	296
297	298	299	300	301	302	303	304	305	306	307	308	309	310

There is a $5.00 postage & handling charge for each TSP ordered, payable by check or credit card.

Method Of Payment:

❒ Check to *NASA Tech Briefs*

❒ American Express ❒ VISA ❒ Mastercard

Card No. ______________________________

Exp. Date ______________________________

Signature ______________________________

No. of TSPs: ______ x $5.00 each = total enclosed: $__________

Circle the numbers below to receive more information about products and services featured in this issue.

401	402	403	404	405	406	407	408	409	410	411	412	413	414
415	416	417	418	419	420	421	422	423	424	425	426	427	428
429	430	431	432	433	434	435	436	437	438	439	440	441	442
443	444	445	446	447	448	449	450	451	452	453	454	455	456
457	458	459	460	461	462	463	464	465	466	467	468	469	470
471	472	473	474	475	476	477	478	479	480	481	482	483	484
485	486	487	488	489	490	491	492	493	494	495	496	497	498
499	500	501	502	503	504	505	506	507	508	509	510	511	512
513	514	515	516	517	518	519	520	521	522	523	524	525	526
527	528	529	530	531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550	551	552	553	554
555	556	557	558	559	560	561	562	563	564	565	566	567	568
569	570	571	572	573	574	575	576	577	578	579	580	581	582
583	584	585	586	587	588	589	590	591	592	593	594	595	596
597	598	599	600	601	602	603	604	605	606	607	608	609	610
611	612	613	614	615	616	617	618	619	620	621	622	623	624
625	626	627	628	629	630	631	632	633	634	635	636	637	638
639	640	641	642	643	644	645	646	647	648	649	650	651	652
653	654	655	656	657	658	659	660	661	662	663	664	665	666
667	668	669	670	671	672	673	674	675	676	677	678	679	680
681	682	683	684	685	686	687	688	689	690	691	692	693	694
695	696	697	698	699	700	701	702	703	704	705	706	707	708
709	710	711	712	713	714	715	716	717	718	719	720	721	722
723	724	725	726	727	728	729	730	731	732	733	734	735	736
737	738	739	740	741	742	743	744	745	746	747	748	749	750
751	752	753	754	755	756	757	758	759	760	761	762	763	764
765	766	767	768	769	770	771	772	773	774	775	776	777	778
779	780	781	782	783	784	785	786	787	788	789	790	791	792
793	794	795	796	797	798	799	800	801	802	803	804	805	806
807	808	809	810	811	812	813	814	815	816	817	818	819	820
821	822	823	824	825	826	827	828	829	830	831	832	833	834

Mail in envelope to:

NASA Tech Briefs
PO Box 5077
Pittsfield, MA 01203-5077

or fax to: (413) 637-4343

Thank you for your order.

ments on microwave heating of simulated heart tissue (see Figure 2).

This work was done by G. D. Arndt of **Johnson Space Center;** *J. R. Carl, G. W. Raffoul, and V. G. Karasack of Lockheed Engineering and Sciences Co.; and T. Pacifico and C. F. Piper of Baylor College of Medicine. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Life Sciences category,* ***or circle no. 176*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center; (713) 483-4871. Refer to MSC-22483.

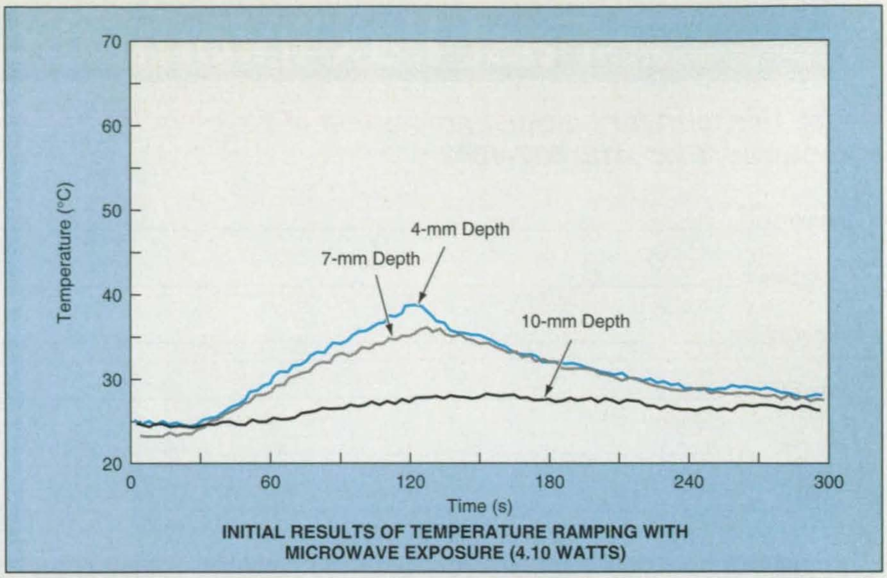


Figure 2. **Temperature Ramping** is shown here as a function of 4.10-W microwave exposure for various depths.

Automated Microspectrofluorimeter and Cell-Culture Apparatus

Outstanding attributes include compactness, frequency agility, and computer control.

John F. Kennedy Space Center, Florida

A developmental compact instrument for experimentation on live cells includes a cell-culture-and-imaging module plus a frequency-agile microspectrofluorimeter for examining the cells. The cell-culture-and-imaging module not only maintains cell cultures but also provides for the necessary transfers of substances to change nutrient media and to stimulate, fix, and label cultured cells. The microspectrofluorimeter provides tunable, multiple-wavelength visible light to illuminate the specimens; acquires quantitative, spectrally-resolved images of single cells; digitally processes the images; and stores the resulting data.

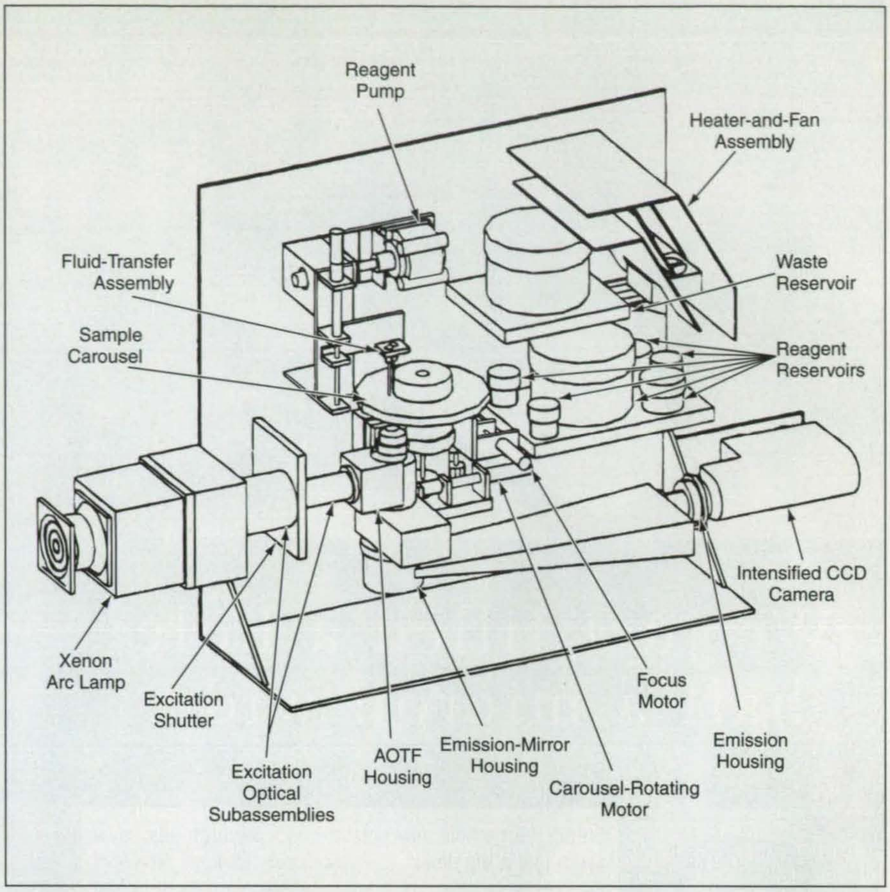
The instrument is designed to operate under computer control; it can be programmed to perform a variety of functions and left to operate unattended after initial loading with cells, culture media, stimulatory chemicals, inhibitory chemicals, and/or other materials. Originally intended for use aboard a spacecraft, the instrument also offers advantages for terrestrial laboratory and field experimentation and clinical investigations; its automation, programmability, and frequency agility could prove beneficial in such applications as cytometry and pathological examinations of biopsy specimens.

Of all the innovations incorporated into the design of the instrument, the one that contributes most to miniaturization and that makes frequency agility possible is the use of one acousto-optical tunable filter (AOTF) instead of a conventional scanning monochromator or stepped-filter-wheel monochromator to obtain the required frequency (wavelength) selectivity and tunability. A typical conventional scanning monochromator has dimensions of about 15 by 15 by 10 in. (38 by 38 by 25 cm), is delicate, includes stepping motors and other moving parts, has low optical throughput, and is constrained to scan sequentially, with attendant slow switching between wavelengths. A stepped-filter-wheel monochromator is limited to the few fixed wavelengths of the filters in the wheel.

In contrast, AOTFs are rugged, monolithic solid-state units that contain no moving parts; are electronically tunable with rapid, random-access switching to any wavelength in range; offer high optical throughput; and are very small [typically, 1 in.^{3} (16 cm^3)]. Unlike monochromators, AOTFs are capable of spectrally resolved imaging. The present instrument exploits this capability to achieve microscopic imaging. Thus, the instrument can be used, for example, to measure fluorescence in single live cells, rather than being limited to measurements in bulk cell suspensions.

The figure shows the major parts of the instrument. The cell-culture-and-imaging module includes a sample carousel that contains 40 0.2-mL culture chambers. The contents of each chamber can be observed via a coverslip on the bottom of the carousel, and access to each chamber can be gained via two septa at the top. Fluids can be pumped from any of 6 reservoirs into any of the 40 culture chambers. A subsystem that maintains optimum cell-culture conditions is included in the module.

The microspectrofluorimeter is configured as an AOTF-based fluorescence microscope. The source of light is a xenon arc lamp. Images are detected by an intensified charge-coupled-device (CCD) camera. Also included in the instrument are (1) a module that contains power-supply circuits plus other electronic circuits for operating the cell-culture-and-imaging module and (2) a control module that contains the equivalent of a 486-level personal computer, with image-processing and communication circuit boards. Software in the control module controls all functions necessary for complete automation of cell-culture and image-data-acquisition functions.



All of the Instrumentation needed to culture cells and examine them microspectrofluorometrically is contained in one compact package.

This work was done by Salvador M. Fernandez, Ernest F. Guignon, Ralph Levy, Sean Cobane, and Robert Kersten of Ciencia, Inc., for **Kennedy Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Life Sciences category,* ***or circle no. 157*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Salvador M. Fernandez, President
Ciencia, Inc.
111 Roberts Street, Suite C
East Hartford, CT 06108

Refer to KSC-11835, volume and number of this NASA Tech Briefs *issue, and the page number.*

New on the Market

Tricor Systems, Elgin, IL, offers the Model 805A PC-based **surface analysis system,** which measures and analyzes the gloss levels of surfaces regardless of shape, texture, or color. It also measures distinctness of image and haze index, and characterizes texture. The high-resolution video imaging system quantifies surfaces of plastics, composites, ceramics, vinyls, and coated and painted surfaces using up to 240,000 data points across the measured area.

For More Information Circle No. 735

The TS Series of **linear stages** from Newport Corp., Irvine, CA, are available in travel ranges from 50mm to 300mm with bi-directional repeatability and minimum incremental motion of 0.5μm. They are machined from 7075 aluminum and feature a DC servo motor, acceleration range from 0.001 to 0.20g, and a velocity range from 0.05 to 75mm/sec. The stages are supported by crossed-roller bearings and feature an integral linear optical encoder.

For More Information Circle No. 743

Methode Electronics, Connector Products, Chicago, IL, offers a 50-position **CompactFlash PC card receptacle** for CompactFlash form-factor removable memory devices in handheld computers, digital cameras, PDAs, and other portable devices. Features include flexible contact tail tool forming and a contact design that withstands repeated card insertions in excess of 10,000 cycles. All materials are compatible with high-temperature soldering processes.

For More Information Circle No. 742

The ADAM 3000 series **signal conditioning modules** from American Advantech, Sunnyvale, CA, protect processed signals from harmful effects of ground loop, motor noise, and electrical interference. They provide three-way 1000VDC isolation, an internally isolated single +24VDC power supply, and DIN-rail mounting. The modules have a maximum ±177μV/°C temperature drift with up to 1 KHz bandwidth using 0.8W.

For More Information Circle No. 747

The PRIMUS **modular chassis** from Knürr USA, Simi Valley, CA, is integrated with enclosure, backplane, power supply, thermal management, cabling, and shielding. The 19" chassis meets EMI/RFI specifications and MIL-STD-810E requirements for shock resistance. Cooling options provide ventilation while maintaining shielding and stability. Assembly features include retro-fittable components and a push-fit connection system.

For More Information Circle No. 740

Wenco Electronics, Roseburg, OR, has introduced the Celtronic **battery recharger,** which re-energizes nickel-cadmium, nickel metal hydride, and lithium ion rechargeable batteries. Single-, double-, and quad-station models are available that can service 80, 160, and 320 batteries per month, respectively. Features include Smart Port cable hook-up jacks and universal battery connection cables.

For More Information Circle No. 745

Dataq Instruments, Akron, OH, offers the Model DI-400 Series 16-channel, single-ended/8 differential **data acquisition cards,** which feature a 12-bit analog-to-digital converter, dual 12-bit digital-to-analog converter, and eight digital inputs and outputs without direct memory access. Analog inputs may be expanded to 256 channels. The ISA plug-in card contains an on-board 32-million-instruction-per-second digital signal processor.

For More Information Circle No. 746

New on the Market

The Model 2410 and 2420 SourceMeter **voltage and current test instruments** from Keithley Instruments, Cleveland, OH, combine voltage and current sources with a high-resolution digital multimeter and measurement firmware. The 2410 generates source voltages from ±5μV to ±1100V and measures voltage from ±1μV to ±1100V. The 2420 generates source current from ±500pA to ±3A and measures current from ±100pA to ±3A. Memory buffer allows storing up to 5000 5-1/2-digit readings.

For More Information Circle No. 738

The LV3000 Series low-voltage, high-current switch mode **power supplies** from HC Power, Irvine, CA, feature output voltages of 1.25, 2, 3.3, 4.5, 5, 12, and 18 VDC. The 3000W power supplies are nominally rated for 5 volts at 500 amps, with an optional 3.3 volts at up to 800 amps. The units provide standard AC input of 180 to 264VAC, single-phase 47-63Hz.

For More Information Circle No. 744

Interpoint, a subsidiary of Crane Co., Redmond, WA, has introduced the SMHF and SMSA radiation-hardened **DC/DC converters** and the SFMC **EMI filter,** all of which function over a temperature range of -55°C to +125°C. The SMHF converter delivers up to 15 watts of output power with single outputs of 3.3, 5, 12, or 15 VDC; the SMSA provides up to 5 watts of output power in single- or dual-output configurations of 5, 12, or 15 VDC. The SFMC filter is compatible with both converters.

For More Information Circle No. 739

Spira Mfg. Corp., North Hollywood, CA, has introduced the Flexi-Shield **EMI gasket,** which is made by wrapping a conductive spiral around a soft silicone tube or cord. The design flexes to fill uneven joint surfaces and features a low coefficient of friction. Standard materials are stainless steel and beryllium copper.

For More Information Circle No. 748

Setra Systems, Boxborough, MA, has introduced the BL and EL **precision balances,** which incorporate variable capacitance technology and a Moment Insensitive Load Cell. Features include an LED display, bi-directional RS-232 data communications, die-cast aluminum housing, stainless steel weighing pan, and leveling controls. Capacities range from 200 to 4100 grams.

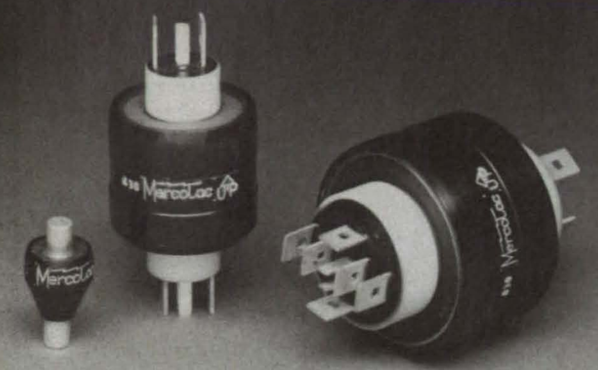
For More Information Circle No. 737

The DataGraph VR series videographic **paperless recorders** from Total Temperature Instrumentation, Williston, VT, measure, compute, display, record, and review up to 12 analog and computation channels. Color and monochrome versions feature 5" active matrix LCD display, 16-bit resolution, math functions, data analysis while recording, and software that enables data export to a PC.

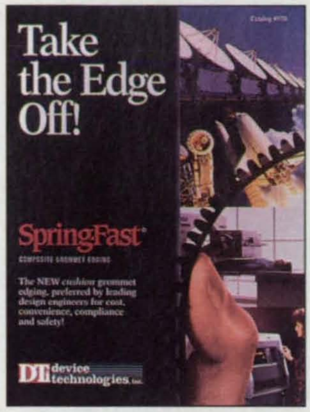
For More Information Circle No. 736

For More Information Circle No. 421

For More Information Circle No. 422



New Literature

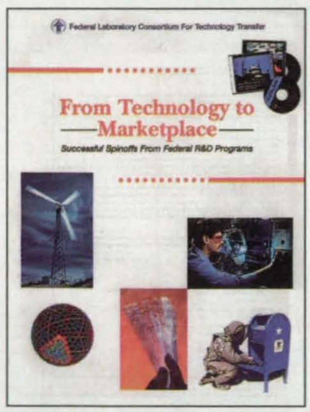


Device Technologies, Marlborough, MA, has released a new brochure describing UL94V-0 Spring-Fast® composite **grommet edging,** which protects wires and cables from abrasion. Applications include aerospace, fiber-optic telecommunications, computers, and medical equipment.

For More Information Circle No. 700

A product selection guide from ENM, Chicago, IL, describes **counting instruments** such as electrical, electronic, and mechanical counters; hour meters; and LCD timers. Panel-mount, miniature, self-powered, and dual-purpose counters also are featured.

For More Information Circle No. 703



The Federal Laboratory Consortium for Technology Transfer, Sequim, WA, offers a 20-page brochure describing more than 50 successful **technology transfer spinoffs** from federal R&D programs. Spun-off commercial products and processes in sports and recreation, health and medicine, safety, computers, electronics, manufacturing, and the environment are featured.

For More Information Circle No. 704

A six-page brochure from LNP Engineering Plastics, Exton, PA, describes Lubriloy® D wear-resistant **alloy composite.** The lubricated polycarbonate compound features shrink rates and flow similar to standard flow, neat polycarbonates.

For More Information Circle No. 705

A Digital Design and Debug catalog from Hewlett-Packard, Palo Alto, CA, features **prototype debugging tools** such as logic analyzers, emulators, processor probes, mixed-signal oscilloscopes, and PCI-bus verification tools. The 24-page catalog for software and hardware engineers, firmware designers, and systems integrators also describes custom debugging solutions.

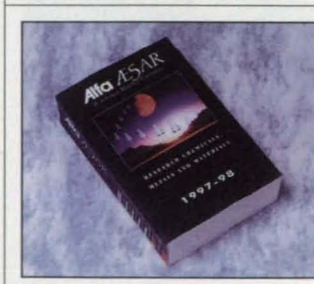
For More Information Circle No. 707

Ergotron, St. Paul, MN, offers a brochure describing ergonomic **computer component mounting accessories,** including adjustable wall, ceiling, and floor mounts for computers; suspension components; keyboard holders; storage drawers; and computer work centers. Touchscreens, laptop computers, and full-size monitors can be mounted for use in sitting or standing positions.

For More Information Circle No. 706

A 28-page catalog from Techno-Sommer Automatic, New Hyde Park, NY, describes PowerStop **industrial shock absorbers** for applications such as parts movement on rotary tables or conveyor belts, load lowering, and pneumatic delivery systems. Fifteen models are available in 18 sizes with various stroke lengths.

For More Information Circle No. 701

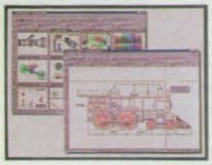


Alfa Aesar, a Johnson Matthey Co., Ward Hill, MA, has released an 1,800-page 1997-98 catalog of more than 12,000 **research chemicals, metals, and materials.** Included are inorganics, organics, pure elements, precious metal compounds, catalysts, rare earth compounds, pure metals, and alloys.

For More Information Circle No. 702

New on Disk

Product of the Month

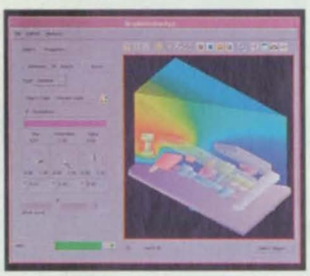


SoftSource, Bellingham, WA, has introduced Vdraft™ AutoCAD-drawing-based **CAD software** for Windows 95/NT, the first program produced outside of Autodesk that can create and edit AutoCAD drawings and DXF files in their native format with no translation. Hundreds of drawings can be viewed and edited simultaneously, each in their own window. Commercial plug-in versions of the Vdraft Internet Tools are included for DXF, DWG, and SVF, and are compatible with Netscape Navigator and Microsoft Explorer. It writes and reads AutoCAD drawings from Release 2.5 to 13, and supports direct e-mail of drawings. The cost is $495.

For More Information Circle No. 711

Version 4.0 of Visual Designer™ **data acquisition and control software** from Intelligent Instrumentation, Tucson, AZ, is an application generator for PC-based data acquisition. The 32-bit program can be used to develop Win32 applications for use in Windows 95 and NT environments. Enhancements include support for object linking and OLE automation, and support for GPIB instruments and RS-232/422/485 serial devices.

For More Information Circle No. 710



Advanced Visual Systems, Waltham, MA, offers Version 3.1 of AVS/Express **3D data visualization and imaging software** that enables visualization of complex data, image processing, graphics display, Web interaction via VRML output capability, database connectivity, and user interface construction. An object-oriented visual programming interface connects the components to generate 3D visualizations and 2D plots and graphs. It operates on Windows 95/NT, UNIX, and the Internet.

For More Information Circle No. 712

2D/RS **electromagnetic and thermal CAE software** for Windows 95 and NT is available from Integrated Engineering Software, Winnipeg, Manitoba, Canada. The software consists of ELECTRO electrostatic field solver; MAGNETO magnetostatic field solver; OERSTED time-harmonic field solver; and KELVIN, a heat transfer analysis solver. The program is based on the Boundary Element Method (BEM) of advanced numerical algorithms, and features an enhanced file manager.

For More Information Circle No. 713

Wrap™ 1.0 **modeling software** from Raindrop Geomagic, Champaign, IL, provides automatic surface reconstruction and grid generation from arbitrary point cloud data. It can automatically wrap a surface around an arbitrary point cloud and concurrently construct surface and volume meshes, and features a variety of output formats.

For More Information Circle No. 715

VARIMETRIX North America, Irvine, CA, has released VARIMETRIX **parametric solid and surface modeling software**, a suite of CAD/CAM/CAE tools with IGES, DXF, and STL data translators. The software allows simultaneous modeling using solids, surfaces, and wireframe, as well as unlimited undo/redo and machine tool simulation.

For More Information Circle No. 714

Numerical Control Computer Sciences, Irvine, CA, has introduced NCL Version 8.4 **CAM software** for multi-axis machining that generates simultaneous two- through five-axis NC tool paths and provides parametric 3D modeling. Geometric modeling and toolpath functions are fully associative: a change to the model results in an immediate change to corresponding tool paths.

For More Information Circle No. 716

PCB Viewpoint for Windows™ **3D PCB viewing software** from Router Solutions, Newport Beach, CA, is an add-on module to the CAMCAD™ PCB view, print, compose, and convert program. The module enables 3D viewing of PCB designs and import PCB design system translators such as PADS, Cadence, Mentor, GenCAD and Oracle.

For More Information Circle No. 717

NASA Tech Briefs, ISSN 0145-319X, USPS 750-070, copyright© 1997 by Associated Business Publications Co., Ltd. Copyright is not claimed for the individual "tech briefs" contained in this publication. The U.S. Government has a paid-up license to exercise all rights under the copyright claimed herein for government purposes. NASA Tech Briefs is published monthly by Associated Business Publications Co., Ltd., 317 Madison Ave., New York, NY 10017-5391. Editorial, sales, production and circulation offices at 317 Madison Ave., New York, NY 10017-5391. Subscription for non-qualified subscribers in the U.S., Panama Canal Zone, and Puerto Rico, $75.00 for 1 year; $125.00 for 2 years; $200.00 for 3 years. Single copies $10.00. Foreign subscriptions one-year U.S. Funds $195.00. Remit by check, draft, postal, express orders or VISA, MasterCard, or American Express. Other remittances at sender's risk. Address all communications for subscriptions or circulation to NASA Tech Briefs, 317 Madison Ave., New York, NY 10017-5391. Second Class postage paid at New York, NY and additional mailing offices.

POSTMASTER: please send changes to NASA Tech Briefs, P. O. Box 10523, Riverton, NJ 08076-0523.

Advertisers Index


Body-building equipment
Developed 1995.
MANUFACTURING
MEDICAL
MATERIALS
SENSORS
NASA
NASA engineers have partnered with thousands of companies to develop new products. Like an exercise machine patterned after a zero gravity simulator. It's now in health clubs nationwide.
To learn how you can tap into our 100 billion dollars of R&D, visit our Web site. Or call the National Technology Transfer Center to find out how our technology can help your bottom line.
http://ntas.techtracs.org 1-800-678-6882
© 1997 National Aeronautics and Space Administration